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ABBOTT, W. OSLER	. 691	DAVIS, WARREN B	809	HIGGINS, CHARLES C	549
ABELL, IRVIN	348	DEAVER, J M	062	HINMAN, FRANK	329
ALBEE, FRED H	. 797	DEUTERMAN, JOEL L	.. 314	HOLMAN, EMILE	217
ALTIMAS, G. T	. 176	DIXON, CLAUDE F.	314	HUNDLEY, J. MASON, JR	360
ANDERSON, F. O	.. 176	DOLKART, RALPH F	79		
ANDREWS, EDMUND	748	DOUBILET, HENRY	882	INMAN, VERNE	288
ANSON, BARRY J.	. 186	DRASTEDT, C A	987		
ARONSOHN, HANS G	.. 748	DROSIN, LOLIS	1038	JOHNSTON, CHARLES C	691
		DUMLER, JOHN C	360	JONES, T. E	925
				JORDAN, HENRY	95
BACON, HARRY E	. 105			JOSLIN, HOPE L	902
BAILEY, ORVILLE T	. 100	EDWARDS, EDWARD A	. 236		
BARDEN, ROBERT P	. 819	ELIASON, E. L	.. 1068		
BERMAN, J. K.	. 11	ENGEL, GILSON COLBY	.. 405	KAUFMAN, PAUL A	1
BESLEY, FREDERIC A	.. 443			KEHOE, ROBERT A	144
BEST, R. RUSSELL	1040	FARRAR, LILLIAN K P	. 44	KESTEN, BEATRICE M	628
BISCARD, J DEWEY	173	FARRELL, JAMES I	657	KIRWIN, THOMAS J	090
BLUMENFELD, CHARLES M	.. 179	FARRIS, J. MATTHEWS	173	KNAPP, PAUL A	979
BONAR, BARNET E	179	FAY, TEMPLE	. 512	KOPETZKY, SAMUEL J.	395
BOSWORTH DAVID M	646, 912	FEINER, DAVID	. 790	KRAISS, CORNELIUS J	628
BOWER, JOHN O...	.. 947	FOSS, HAROLD L	556	KRONFELD, PETER C	389
BOYDEN, EDWARD A	. 145	FRANK, IRVING L	819	KRUSEN, FRANK H	248
BRANCH, CHARLES D	100	FRASER, JOHN R.	437	KUSHNER, ALEXANDER	707
BROWN, CLARENCE F G	. 79	FURSTENBERG, A. C	400		
BROWN, CLARK E	. 611			LAHEY, FRANK H	775
BURNS, JOHN C	. 947	GALLAND, WALTER I	95	LAMPSON, R. S	975
BURT, C V.	1054	GARDNER, W. JAMES	804	LAVALLE, CARLOS ROBERTSON	55
BUTLER, EDMUND	. 448	GARLOCK, JOHN H	534	LEITER, H. C	677
BUTT, HUGH R	684	GATCH, W. D...	322	LEJEUNE, FRANCIS E	405
		GERDES, MAUDE M	145	LEWIS, DEAN	300
CAHILL, JAMES A., JR	459	GESCHICKTER, C I	300	LEWISOHN, RICHARD	215, 563
CAMPBELL, WILLIS C	466	GLASSMAN, OSCAR	858	LIEBOLT, FREDERICK LEE	1008
CARRELL, W. B.	. 506	GOODALL, J R.	176	LOCKHART-MUMMERY, J. P	257, 527
CAULFIELD, PHILIP A	459	GRADLE, HARPA S	380	LONG, F. A	937
CAVE, HENRY W.	. 308	GRAHAM, ALLEN	577	LUCKHARDT, ARNO B	125
CHEATLE, GEORGE LENTHAL	525	GRAHAM, ROSCOE R	269	LUND, CHARLES C	810
CIMOTTI, J GRIER	628	GRAY, LAMAN A	157	LUNDY, JOHN S	935
CLEVELAND, MATHER	646	GREENE, R R.	987	LYMAN, YALE	657
CLOCK, RALPH OAKLEY	878	GURD, FRASER B	489	LYNCH, FRANK W	423
CLUTE, HOWARD M.	122				
COHEN, MANDEL E	591	HABEIN, HAROLD C	994	MACARTHUR, CLYMONT	166
COLP, RALPH	882	HACHTEL, FRANK W	360	MACEachern, MALCOLM T	421
CONWAY, FRANCIS M	222	HALEY, PAUL W	166	MACHT, DAVID I	732
CONWAY, HERBERT	140, 1024	HAMMATT, HAROLD	622	MACPHAIL, F L	176
COOPER, ZOLA K	989	HANSSON, K G	475	MARTIN, A G	962
CORYLLOS, POL N	698	HANTMAN, HAROLD	166	MAY, HANS	495, 666
CROWELL, BOWMAN C	419	HARRIS, FRANKLIN I	. 88	McCLURE, ROY D	1064
CURTIS, ARTHUR H	432	HARTZELL, JOHN B	108	McCORD, JAMES R	441
CUTLER, ELLIOTT C	637	HARVEY, SAMUEL C	123, 814	McDONALD, ELYCE	246
		HAUSER, EMIL D W	199, 1032	McGOWAN, JOHN M	979
DAPRACH, WILLIAM	815	HAWKES, STUART Z	62, 166	McVAY, CHESTER B	186
DAVIS, DAVID M	940	HENNY, GEORGE C	512	MEANS, J H	264
DAVIS, M EDWARD	426	HERRICK, W W	37	MELEVNEY, FRANK L	117

MENCHER W H	677	PUESTOW CHARLES B	622	STEIN JUSTIN J	90
MENGLE HAROLD A	947			STEINDLER ARTHUR	66
MEYER SAMUEL J	330	RANDALL ALEXANDER	927	STEVENSON CHARLES SUMMERS	81
MILLER ARTHUR G	723	RAVDIN I S	819		
MOCK HARRY E	79	RENNIE J GORDON	1034	TAUSSIG JOSEPH	98
MORTON PAUL C	769			THOMPSON GERSHOM J	99
MURRAY D T	937	SAUNDERS JOHN B DE C M	233	THOMPSON WESLEY D	81
		SCAGLIETTI OSCAR	868	THOMSON K JEFFERSON	50
NAFFZIGER HOWARD C	238	SCHAAF ROYAL A	166	TILLMAN ALVIN J B	3
NECHOF HAROLD	836	SCHILLER WALTER	129	TOLROFF ARTHUR S W	83
NEWQUIST M N	454	SCHRAGER V L	785	TURNER OSCAR A	80
NOVAK, EMIL	157	SCIPIADES ELEMER, JR	822		
NOVEY M ALEXANDER	671	SCOTT W J MERLE	933	UHLE CHARLES A W	92
		SCUDDER CHARLES L	479		
Ogilvie W H	436	SEEGER STANLEY J	1065	WAGNER J HUBER	48
ORELL SVANTE	23	SEELIG M G	989	WAKEFIELD E G	99
ORR II WINNETT	683	SELF EDWARD B	117	WALTERS WALTMAN	91
ORTMAYER MARIE	778	SHEA JOHN J	408	WARREN SHIELDS	61
OWEN HUBLEY R	500	SHERMAN WILLIAM O NEILL	353	WEBER HARRY M	31
		SIEGEL ISADORE A	360	WEINSTEIN M L	27
PHALEN JAMES M	1072	SIMEONE F A	975	WILENSKY ABRAHAM O	
PHENISTER DALLAS B	1077	SMITH ALBERT R	663	WINDLE W F	98
PONCHER HENRY G	612	SNELL ALBERT M	979		
POOL EUGENE H	414	SPARLING DOUGLAS	437	ZIEMAN STEPHEN A	23
POTTER ALFRED H	604	SPRAGUE EDWARD W	166	ZIMMERMAN LEO M	19
FRANGEN AVERY DEH	385	STFIN HARRY C	839	ZOLLINGER ROBERT	100 63
PRIDE W T	1047				

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HURTHLE CELL TUMOR OF THE THYROID GLAND

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THE established value of clinicopathological studies has prompted us to report 2 cases of an unusual thyroid tumor which, because of its relative rarity and undetermined clinical significance, should be added to the meager relevant literature so that one may arrive at certain conclusions from the examination of the collective experience.

The following questions will be discussed: (1) The cell of origin of the Hurthle cell tumor; (2) the important clinical phenomena associated with this tumor; (3) the relationship of the tumor as regards its benignity or malignancy; (4) the treatment; and (5) the value of radiation therapy.

GROSS AND MICROSCOPIC ANATOMY

The question of cell classification of the Hurthle cell type of neoplasm with special regard to the cell prototype has not yet been definitely established. The most likely sites of origin are the cells of the thyroid or of the branchiogenetic structures, especially the parathyroids¹

The thyroid It has always been difficult to differentiate the normal elements of the thyroid because of the extreme lability of its cellular elements. Variations in size and structure occur from day to day, and according to the season, the climate, the geographi-

cal location, age, sex, food, the state of nutrition, and, most important of all, in accordance with the amount of available iodine.

In mammals the thyroid consists of two lobes which lie on either side of the trachea, about the level of its juncture with the larynx. There is marked variation in its position, both in different, and within the same, species. The human thyroid in particular varies greatly from the theoretically normal type. Complete absence of the thyroid anlage has been observed (Maresch, 1898; Erdheim, 1904). A third "pyramidal" lobe occurs commonly. Isolated masses of thyroid tissue are found along the line of descent of the thyroglossal tract usually known as "lingual," "sublingual," "suprahyoid" and "infrahyoid" thyroids. Accessory or aberrant thyroid tissue apart from that developed from the thyroglossal tract occurs commonly in man in the region of the ascending and transverse portions of the aortic arch. More rarely thyroid fragments are present in the thymus, at the bifurcation of the trachea, or as far down as the esophageal opening in the diaphragm.

There is some doubt as to the single and median origin of the thyroid in mammals. In all other vertebrates the uniformity of the origin of this gland has long been established by the work of Stieda (1881), Born (1883), His (1885), Kastschenke (1887), Van Bemmelen (1889), Maurer (1888, 1889), and Herrmann and Verdun (1900). The thyroid gland is developed from a median diverticulum on the summit of the tuberculum impar which grows downward and backward as a tubular duct, which subsequently divides into a series of cellular cords, from which the isthmus and lateral lobes of the thyroid gland are developed. The ultimo-branchial bodies from the fifth pharyngeal pouches are enveloped by the lateral lobes of the thyroid gland

¹We are indebted to Keibel and Mall's Embryology, to Cowdry's book on Special Cytology, and to Gray's Anatomy for the embryological, anatomical and microscopic data which follow.

and atrophy and do not form true thyroid tissue. The thyroglossal duct which connects the diverticulum with the pharynx undergoes degeneration and disappears later, its upper end being represented by the foramen cecum of the tongue and its lower by the pyramidal lobe of the thyroid gland.

The development of the thyroid anlage usually occurs as anastomosing solid cords which are cut up by the ingrowth of vessels and stroma to form a follicular structure. The primary follicles arise by the rearrangement of the cells, cell proliferation, increases in the size of the cells and lumen formation. The further growth of the thyroid requires the formation of new follicles from the primary follicles. These are usually formed from solid epithelial bands or hollow buds the cavities of which are at first continuous with the original follicle lumen.

The unit of the thyroid is the individual follicle. The follicles are irregularly rounded or elongated closed spaces of variable dimensions lined by a single layer of cuboidal epithelium resting on a condensed layer of connective tissue which, however, is not considered a true basement membrane. Langendorff and all subsequent observers have demonstrated two types of cells: (1) a majority of chief cells and (2) a minority of colloid cells. There is a variable distribution of the colloid cells and occasionally whole follicles may be composed of these cells. The evidence which is at present available would indicate that the chief cell (the Bensley (filled colloid) cell and the Langendorff (empty colloid) cell) probably represent stages of the secretory cycle through which the characteristic thyroid cell passes.

There are variable groups of small follicles and undifferentiated thyroid cells lying between the larger follicles. Most numerous during fetal life and infancy they normally decrease or disappear with age. They may be considered as new follicles in various stages of development as a result of increased growth stimulation whenever a sufficient stimulus for increased thyroid activity is applied which usually happens in association with goiter formation.

Actively phagocytic reticulo endothelial cells (tissue mast cells of the older workers) occur also in the interfollicular stroma. According to Williamson and Pearse (1926) they are more prominent in the hyperplastic gland and these authors assume that they take part in the normal activities of the thyroid. These cells have no morphological relationship to the Hurthle type cell.

Large oxyphilic cells are also described by Hurthle, Baber, Langendorff and others as occurring in the interfollicular spaces of the normal thyroid. There is no uniformity of opinion concerning these cells however.

The parathyroids. The parathyroid bodies are developed as outgrowths from the third and fourth branchial pouches. In connection with the fourth parathyroids a cystic endodermal rest corresponding to the postbranchial or ultimobranchial body or

lateral thyroid anlage may usually be found. Normally there are four glands situated two on either side, very difficult to recognize and find, there is very little variation from this normal.

Microscopically the parathyroids consist of intercommunicating columns of cells supported by connective tissue containing a rich supply of blood capillaries.

The parenchyma of the parathyroid is made up of closely packed relatively large cells. Three types of cells are distinguishable: (1) chief cells, (2) small dark chief cells (Peterson 1903, Getzowa 1907, Noodt, 1922) and (3) large bright oxyphilic cells (Welsh, 1898).

The clear chief cells appear to be the essential type. They have clear almost unstaining plant like non granular protoplasm with relatively large pale vesicular eccentric nuclei.

The dark chief cells are at best only a subgroup of the chief cells and in appearance they are intermediate between the clear chief cells and the oxyphil cells. There seem to be suggestions that they represent the early stages of the large oxyphil cells.

The oxyphil cells appear in late childhood and are much larger than the chief cells, occur singly or in groups and are characterized by large amounts of granular protoplasm which stain intensely with acid dyes. The nucleus is much smaller than in the chief cells and the chromatin filaments are closely packed and deeply staining.

In infancy only clear chief cells or dark chief cells are present. Oxyphil cells are present only in certain species of animals and in man they increase from about the tenth year of life onward. Three types of cells represent different stages of secretory activity, the oxyphil cells being the mature cells.

HISTORICAL REVIEW

With this anatomical background of the various cell types and structures to be considered in determining the origin of the so called Hurthle cell tumor, we review the reported cases in order to reveal their common features.

As was indicated previously Hurthle in 1894 described a large oxyphilic parafollicular thyroid cell as a part of the structure of the normal thyroid gland. He did not describe any thyroid tumors composed of this cell type but the similarity between the cell he described and that forming the prototype of the tumors we are discussing prompted later writers to designate them by the term "Hurthle cell tumors."

The first reference to these tumors was made by Langhans in 1907, who applied the descriptive designation "small alveolar, large cell struma" to them. He reported 5 such cases, the histories of which are abstracted here:

CASE 1 From Professor Kocher. Female, aged 55 years, had a colloid struma of the isthmus which had been growing rapidly in the last 3 months. Two nodules were noted, one walnut sized, one 9 by 5½ by 4½ centimeters, each with smooth surfaces. On section, there was noted a lobular structure of gray, brown, red color, translucent, very granular, and with radiating septa containing transected vessels. There was evidence of recent hemorrhage in both nodules.

CASE 2 From Professor Niehaus. Male, aged 68 years, had had a goiter for 15 years. Respiratory difficulty had been noted for 1 year, and had become worse in the last 3 weeks with rapid growth of tumor. Exitus occurred immediately after operation. The postmortem examination showed metastases to the lungs and the liver.

CASE 3. From the Surgical Clinic of Bern. Female, aged 41 years, had had a thyroidectomy 12 years ago, for a large growth. Recurrence had taken place, with rapid growth in the preceding 6 months. Tumor measured 12 by 8.5 by 10 centimeters and was adherent to the trachea. The patient died and the postmortem examination showed pulmonary metastases.

CASE 4 From Professor Kocher. Female, aged 40 years, had a rapidly growing tumor. No further clinical details were given.

CASE 5 From Professor Kocher. Male, aged 32 years. Two surgical specimens were obtained, one egg-sized, one 6 centimeters in diameter. No clinical details were given.

Lobenhoffer, in 1909, while discussing thyroid secretion, refers to 2 cases, abstracted below, which also fit into the category we are describing.

CASE 6 Female, aged 12 years, had a goiter which had grown rapidly in the preceding 6 months. Marked pressure symptoms were present. A resection of the left lobe and isthmus was performed. A small alveolar large cell struma of Langhans was demonstrated microscopically, all gradations being seen between small finely granular acidophilic cells and large coarsely granular cells. The case was considered benign.

CASE 7 A 40 year old woman was operated upon for goiter. No clinical data were submitted. The specimen presented the typical microscopic picture, and was considered benign.

Wegelin, in his monograph on the thyroid in Henke and Lubarsh's *Handbuch*, states

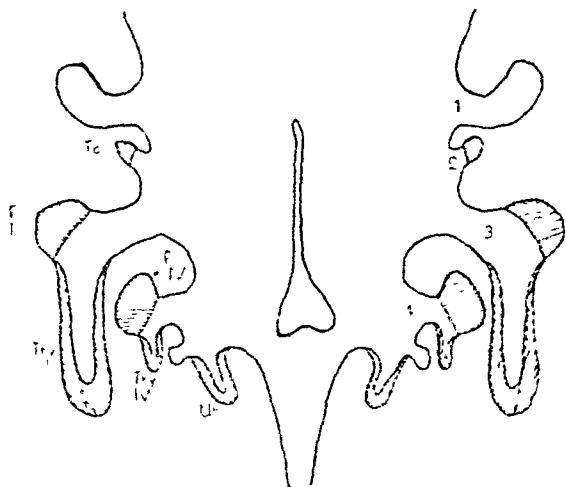


FIG. 1. Diagrammatic representation of the development of the thyroid, parathyroid, and thymus glands. *Tc*, the tonsil; *Pl*, the parathyroids, *I*, *II*, *III*, and *IV*. *Thy*, the thymus, *I*, *II*, *III*, and *IV*. *Ub*, the ultimobranchial body, *1*, *2*, *3*, and *4*, the branchial pouches. (From E. V. Cowdry, *Special Cytology*, after O. Grosser in Keibel and Mall, *Human Embryology*, 1912, 2: 461.)

that he has seen several such tumors in all age groups but that they were all benign. He submits no further clinical data.

Ewing, in his book on neoplastic diseases, also makes passing reference to what he calls "struma postbranchialis (Getzowa) or small alveolar large cell adenocarcinoma (Langhans)" stating that he has examined two tumors answering to that description, but he likewise submits no clinical data and does not indicate whether they were benign or malignant.

Haagensen describes 2 cases of thyroid carcinoma of the "small alveolar, large cell (Hurthle cell)" type. These reports, which are fairly complete, are as follows:

CASE 8 Female, aged 37 years. In 1918 patient had an enlargement of the thyroid associated with nervousness and menorrhagia. In 1924 a partial thyroidectomy was performed. The tumor measured 8 by 5 centimeters and there was perforation of the capsule. "Patient referred to Memorial Hospital with considerable tumor remaining." Three half erythema doses of x-ray (low voltage) were given between October, 1924, and January, 1925. The tumor slowly decreased in size. In October, 1930, the tumor was about the same. Pathology: thyroid small alveolar, large-cell (Hurthle cell) carcinoma, Grade II.

CASE 9 Female, aged 38 years. In 1906 following childbirth a goiter was noted which increased in size slowly. In December 1915 the tumor was removed. The specimen was 11 by 8 by 5 centimeters was encapsulated, and it was thought to have been completely removed. In 1914 there was a small recurrence which was treated with radon implantation in July, 1925. In January, 1926 cough and hemoptysis occurred and the patient was admitted to the Memorial Hospital. An 8 by 6 centimeter hard, irregular mass was present at the base of the neck with pulmonary metastases and widening of the superior mediastinum. Improvement occurred for 2 months following high voltage x ray therapy. The cough and hemoptysis ceased after 1 month and the pulmonary metastases decreased in size.

In 1927-1928 4 additional x ray treatments were given. The condition remained unchanged. In July 1929 the cough reappeared and the thyroid mass increased in size in spite of continued x ray therapy. In October 1929, there was back pain. x ray examination showed metastases in the spine. additional x ray therapy was given and a brace was applied. In 1930 x ray therapy was continued. In 1931 the patient weakened considerably; the cough persisted. The neck and pulmonary recurrence remained unchanged but the vertebral metastases increased. Pathology: thyroid small alveolar large cell (Hurthle cell) carcinoma, Grade II. Large cuboidal cells with an acidophil cytoplasm and with small nuclei form compact small irregular alveoli.

Eisenberg and Wallerstein report a single case of Hurthle cell adenoma which was unusual in that it was associated with a toxic goiter.

CASE 10 A woman aged 54 years had a swelling of the neck for years. It had grown appreciably larger in the preceding 5 months during which time she had three spells of unconsciousness each lasting 1 hour. The spells were accompanied by diffuse muscular twitching. Only slow loss of weight occurred in the preceding 5 months with cardiac palpitation on exertion and excitement. No nervousness or perspiration were noted. Menses were normal. The thyroid examination showed diffuse enlargement of both lobes of the thyroid. The neck veins were distended. There were no eye signs and no tremors. The heart was slightly enlarged with a systolic murmur at the apex. A basal metabolic rate of +40 fell to +18 after Lugolization. A right subtotal hemithyroidectomy was done. Ten months later the patient was readmitted with swelling of the left lobe and isthmus of the thyroid. The basal metabolic rate was +41. A left hemithyroidectomy was performed. The basal metabolic rate then fell to +3 and 4 months later to -18.

The microscopic picture showed many small alveoli long strands of palisade like cells and occa-

sionally syncytium like masses. Some alveoli contained a small amount of colloid. The cells were large fat free either polyhedral or irregularly shaped. They were clearly outlined. The cytoplasm was oxyphilic and finely granular. The nuclei were eccentrically placed small and vesicular with nucleoli and they were rich in chromatin. No mitotic figures were seen though a few double nuclei were noted. In addition the picture of toxic non exophthalmic goiter was present with many areas of lymphocytic infiltrations. The diagnosis was toxic non exophthalmic goiter and Hurthle cell adenoma of the thyroid gland.

Clute and Warren, in a review of 226 cases of thyroid cancer, found 1 case of adenocarcinoma of the Hurthle cell type but they did not report any clinical data other than an excellent photomicrograph exhibiting the characteristic appearance of the tumor. They remark "While admittedly the cells resemble the oxyphil cells of the parathyroid, they appear to us to resemble even more closely the acidophilic phase occasionally encountered in the thyroid epithelium itself."

Our experience¹ comprises the following two cases.

CASE 11 Bronx Hospital No 38653. A house wife 47 years of age was admitted to the hospital with a history of generalized arthralgias for the preceding 4 1/2 years and a recent history extending over a period of 6 months of cardiac palpitation tremor sweating and loss of 40 pounds in weight. The physical examination revealed hypertrophic enlargement and restricted motion of all of the joints. There was a firm nodular enlargement of the right lobe of the thyroid gland. The blood Wassermann test was negative. The routine urine examination was also negative. The white blood count and differential count were normal. The vaginal and urethral spreads revealed no Gram negative diplococci. The basal metabolic rate was + per cent.

Following a brief period of Lugolization operation was performed. The tumor was found to involve the right lobe of the thyroid gland and was enucleated with such difficulty that a partial excision of the right lobe of the thyroid gland was necessitated together with the tumor.

The specimen was a reddish brown mass of tissue 3 by 2 centimeters in diameter with some evidence of a thin fibrous capsule about the tumor. Microscopic examination revealed adenomatoid areas in a lymphocytic stroma. There were small areas of adenoma malignum or early thyroid carcinoma. The outstanding feature however was the presence of

¹The pathological examination and the report to the microscopic picture in both of our cases was made by Joseph F. Henrich, Laboratory of the Bronx Hospital. We are indebted to him for his co-operation.

strands and alveoli with papillary overgrowth of Hurthle type oxyphilic cells of characteristic structure. The immediate postoperative course was uneventful and was followed by intensive radiotherapy with a radium collar.

Examination of the patient 3 years later revealed no recurrence of the tumor.

CASE 12 Bronx Hospital No 66465. A housewife, 47 years of age, was admitted with a 2 year history of a slowly increasing swelling in the neck. This was accompanied by some increased nervousness and sweating but there were no cardiac palpitation, tremor, exophthalmos, loss of weight, or any other symptoms of hyperthyroidism; no pressure symptoms were manifested. The physical examination revealed a diffuse firm enlargement of the thyroid gland, particularly on the left side, where a bruit was heard. There was slight cardiac enlargement but no other signs of cardiac disturbance. The white blood count was 8100, the polymorphonuclears, 80 per cent, lymphocytes, 18 per cent, and monocytes, 2 per cent. The routine urine examination was negative. The basal metabolic rate was +22 per cent. The uterus was moderately enlarged by the presence of a fibroid tumor.

Following a brief period of lugolization operation was performed and a large ovoid tumor of the left lobe of the thyroid was enucleated. The remainder of the left lobe of the thyroid was subtotally resected.

The tumor was 5 by 4 centimeters in diameter, brown, and fleshy in appearance. Microscopic examination revealed an area of compact cellular tissue characterized by cords and light foamy polyhedral acidophilic cells with small eccentric nuclei. The remainder of the thyroid gland exhibited areas of varying cellularity, colloid distention, and focal lymphoid infiltration.

The postoperative course was uneventful, and the patient has remained well to this date (8 months).

CLINICAL FACTS

A number of clinical facts have been extracted from this review of the available clinical records of the Hurthle cell type of tumor.

1. In only one of the recorded cases has there been any associated thyrotoxic phenomena. This was Eisenberg and Wallerstein's case. This is remarkable.

2. No case, except one of ours, has shown any association with joint or bone manifestations. In this case, the laboratory and clinical observations have shown no data which could either (a) associate the tumor with any parathyroid structure, or (b) give any inkling of

any metabolic disturbance usually associated with parathyroid activity.

3. There is no evidence that the presence of the Hurthle cell type of tumor has been associated with any other ductless gland disturbances.

4. In the recorded cases 4 "benign" and 6 "malignant" forms of Hurthle cell tumor are described, no statement as to the malignancy or benignancy being made in the remaining cases.

5. In at least 1 case (one of ours) several types of tumor seem to be present.

CELL OF ORIGIN OF HURTHLE CELL TUMOR

As is seen from the preceding anatomical and microscopic descriptions many cells differing only very slightly morphologically exist from which the Hurthle tumor might originate. Difficulty is added by the confusing terminology and nomenclature; for instance, Hurthle cell tumor, Langhans wuchernde struma, Getzowa struma, etc., may or may not be the same entities.

In Langhans' original description of these tumors the cells making up the parenchyma are described as large polyhedral oxyphilic granular cells about 15 or 30 microns in diameter arranged in small alveoli or trabeculae. The nuclei are eccentrically placed, about 6 to 8 microns in diameter, and contain a large amount of chromatin in clumps and threads with a prominent nucleolus. Langhans, as well as other observers, aptly noticed the resemblance of these cells to the parenchymatous cells of the liver and adrenal cortex. Of greatest possible significance, however, was the very close resemblance of the tumor cells to the oxyphilic cells of the parathyroid, a fact which lead a group of observers, notably Eisenberg and Wallerstein, to believe that the tumors are of parathyroid origin. The latter observers bolster up their anatomical data with clinical observations concerning the physiological effects of the tumor which they observed in their patient (*vide supra*).

Eisenberg and Wallerstein consider this as evidence of the presence of a functioning parathyroid tumor although data on the blood calcium or calcium metabolism are not

CASE 9 Female aged 58 years. In 1906 following childbirth a goiter was noted which increased in size slowly. In December, 1915 the tumor was removed. The specimen was 11 by 8 by 5 centimeters was encapsulated and it was thought to have been completely removed. In 1924 there was a small recurrence which was treated with radon implantation in July, 1925. In January 1926, cough and hemoptysis occurred, and the patient was admitted to the Memorial Hospital. An 8 by 6 centimeter hard irregular mass was present at the base of the neck with *pulmonary metastases and widening of the superior mediastinum*. Improvement occurred for 2 months following high voltage x ray therapy. The cough and hemoptysis ceased after 1 month, and the pulmonary metastases decreased in size.

In 1927-1928 4 additional x ray treatments were given. The condition remained unchanged. In July 1929 the cough reappeared and the thyroid mass increased in size in spite of continued x ray therapy. In October, 1929 there was back pain. x ray examination showed metastases in the spine. additional x ray therapy was given and a brace was applied. In 1930 x ray therapy was continued. In 1931 the patient weakened considerably, the cough persisted. The neck and pulmonary recurrence remained unchanged but the vertebral metastases increased. Pathology thyroid small alveolar large cell (Hurtle cell) carcinoma Grade II. Large cuboidal cells with an acidophil cytoplasm and with small nuclei form compact, small irregular alveoli.

Eisenberg and Wallerstein report a single case of Hurtle cell adenoma which was unusual in that it was associated with a toxic goiter.

CASE 10 A woman aged 54 years, had a swelling of the neck for years. It had grown appreciably larger in the preceding 5 months during which time she had three spells of unconsciousness each lasting 1 hour. The spells were accompanied by diffuse muscular twitching. Only slow loss of weight occurred in the preceding 5 months with cardiac palpitation on exertion and excitement. No nervousness or perspiration were noted. Menses were normal. The thyroid examination showed diffuse enlargement of both lobes of the thyroid. The neck veins were distended. There were no eye signs and no tremors. The heart was slightly enlarged with a systolic murmur at the apex. A basal metabolic rate of +40 fell to +18 after lugolization. A right subtotal hemithyroidectomy was done. Ten months later the patient was readmitted with swelling of the left lobe and isthmus of the thyroid. The basal metabolic rate was +41. A left hemithyroidectomy was performed. The basal metabolic rate then fell to +3 and 4 months later to -18.

The microscopic picture showed many small alveoli, long strands of palisade like cells and occa-

sionally syncytium like masses. Some alveoli contained a small amount of colloid. The cells were large, fat free either polyhedral or irregularly shaped. They were clearly outlined. The cytoplasm was oxyphilic and finely granular. The nuclei were eccentrically placed small and vesicular, with nucleoli, and they were rich in chromatin. No mitotic figures were seen though a few double nuclei were noted. In addition the picture of toxic non exophthalmic goiter was present with many areas of lymphocytic infiltrations. The diagnosis was "toxic non exophthalmic goiter and Hurtle cell adenoma of the thyroid gland."

Clute and Warren, in a review of 226 cases of thyroid cancer, found 1 case of adenocarcinoma of the Hurtle cell type, but they did not report any clinical data other than an excellent photomicrograph exhibiting the characteristic appearance of the tumor. They remark "While admittedly the cells resemble the oxyphil cells of the parathyroid, they appear to us to resemble even more closely the acidophilic phase occasionally encountered in the thyroid epithelium itself."

Our experience¹ comprises the following two cases.

CASE 11 Bronx Hospital No 38653. A housewife 47 years of age was admitted to the hospital with a history of generalized arthralgias for the preceding 4½ years and a recent history extending over a period of 6 months of cardiac palpitation, tremor, sweating and loss of 40 pounds in weight. The physical examination revealed hypertrophic enlargement and restricted motion of all of the joints. There was a firm nodular enlargement of the right lobe of the thyroid gland. The blood Wassermann test was negative. The routine urine examination was also negative. The white blood count and differential count were normal. The vaginal and urethral spreads revealed no Gram negative diplococci. The basal metabolic rate was +2 per cent.

Following a brief period of lugolization operation was performed. The tumor was found to involve the right lobe of the thyroid gland and was enucleated with such difficulty that a partial excision of the right lobe of the thyroid gland was necessitated together with the tumor.

The specimen was a reddish brown mass of tissue 3 by 2 centimeters in diameter with some evidence of a thin fibrous capsule about the tumor. Microscopic examination revealed adenomatoid areas in a lymphocytic stroma. There were small areas of adenoma malignum or early thyroid carcinoma. The outstanding feature however was the presence of

¹The pathological examination and the report of the microscopic picture of both of our cases was made by Joseph Folio of the Laboratory of the Bronx Hospital. We are indebted to him for his cooperation.

The classification of Haagensen made in 1931 is made from the Memorial Hospital material, is based upon a series of 30 cases, and is as follows.

- 1 Adenocarcinoma
- 2 Small round cell carcinoma
- 3 Giant cell carcinoma
- 4 Papillary cystadenocarcinoma
5. Small alveolar, large cell carcinoma (Hurthle cell type), 2 cases, 6.6 per cent

Perhaps the most inclusive classification is that suggested by Clute and Warren upon an experience of 226 cases

	Cases
1 Adenoma with blood vessel involvement	99
2 Papillary adenocystoma	51
3 Adenocarcinoma (including Hurthle cell adenocarcinoma)	31
4 Fibrosarcoma	3
5 Epidermoid carcinoma	1
6 Giant cell cancer	11
7. Small cell cancer	30

While certain types of neoplasia appear in each classification, there is no unanimity of opinion as to the various forms of cancer which appear within the confines of the thyroid gland, nor, indeed, is there any uniformity of definition regarding the limits of malignancy as the tumors are histologically portrayed

DISCUSSION

One can predict with a reasonable degree of accuracy the future clinical course of many types of carcinoma of the skin, oral mucous membrane, cervix uteri, and certain other tumors on the basis of their histological features. The prognostic and biological significance of, for example, frequent mitotic figures, anaplasia, invasion, staining qualities, cell arrangement, and other features of established value in general oncology are found notoriously inadequate in their application to thyroid tumors. This has led to a great deal of confusion in terminology, which in turn reflects the fundamental confusion in the criteria for pathological classification. To this day there appears no universally accepted classification of thyroid tumors, and the literature is clogged with such ambiguous and noncommittal terms as "benign metastasizing adenoma," "fetal adenoma," "strumas" of various sorts, and "tumors" not definitely

assigned to a benign or malignant category. The lack of a single *fundamentum divisionis* in the classification of thyroid tumors has resulted in the separation of groups of tumors on various bases with consequent overlapping of groups. This has been further complicated by the known wide range of cell morphology in the normal thyroid gland as a result of physiopharmacological changes. In any attempt at a classification of thyroid tumors prime emphasis should be laid upon the benignancy or malignancy of each tumor type. This is at times difficult to determine, but in the last analysis must conform with the clinical course of the disease. If a tumor produces distant metastases it is malignant no matter how benign its histological structure may appear according to our present methods of analysis. This separation into benign and malignant tumors is of greater biological significance than any superficial similarity of cell types in tumors which are in some cases benign and in others malignant. It is because of the difficulty, at times, in establishing a definitive diagnosis of thyroid carcinoma that one is tempted to discard the fundamental basis of dichotomous division into benign and malignant tumors and to classify several tumors together on the basis of a similar cell structure. It was in this way that the Hurthle cell tumor of the thyroid was first described.

In Langhans' cases the fragmentary published data indicates that although there were no microscopic evidences of malignancy in any of the tumors, not even the characteristic invasion of the blood vessels stressed by Graham, 2 of the patients presented metastases with subsequent death. There can be no question but that these 2 cases represented types of thyroid carcinoma. The 3 other cases may have been benign tumors.

We have studied our 2 cases of so called Hurthle cell tumor of the thyroid from this viewpoint and were able to demonstrate in one case that the tumor was accompanied by an area presenting the usual picture of thyroid carcinoma immediately adjacent to the distinctive Hurthle cell form (Fig. 1). We feel that there is no reason to believe that two separate tumors coexisted in the thyroid but

mentioned. At any rate, even if it were conceded that the Hurthle cell tumor which they removed was a functioning parathyroid tumor, one would expect the episodes of tetany to follow rather than to precede the resection of the tumor. Their view is not generally accepted, however, and the similarity to the parathyroid cells is considered by some to be probably purely coincidental.

Getzowa on analogous grounds has claimed that the Hurthle cell tumors arise from the ultimo branchial bodies a view which while held possible by Langhans is considered unwarranted by Wegelin.

Other observers noting the similarity of the cells to the large oxyphilic interfollicular cells described previously by Hurthle, Baber, Langendorff and others, have considered these cells the true anlagen of these tumors and have accordingly classified them as Hurthle cell tumors. Numerous studies of normal thyroid histology have resulted in conflicting opinions as to the nature of this cell and indeed the existence of any type of interfollicular epithelium has been questioned by many observers. Maksimov and Bloom (13) did not find any interfollicular cells in wax plate reconstructions and therefore consider at least some of the so called interfollicular cell groups as tangentially cut follicular wall, a view also held by Rienhoff, Wilson, and Williamson and Pearse, in their careful researches on the minutiae of thyroid structure make no mention of interfollicular epithelium. Nonidez (17, 18, 19) and Raymond have described parafollicular cells in various laboratory animals as has Zechel (26, 27) who considers them as phases in arrangement of the thyroid parenchyma in the cyclic destruction and regeneration of the follicles. Further doubt is cast upon the anatomical identity of these cells by the fact that, although they are of characteristic appearance, all grades of transition have been found between them and the principal thyroid cells (Langendorff). Maksimov and Bloom (14) believe them in all probability to be dead or dying cells. Wegelin considers the oxyphilic cytoplasm and vesicular nuclei as evidences of degeneration as seen in an anemic infarct of the kidney while Minne's opinion is that such

changes represent a stage in the secretory cycle of the normal thyroid epithelial cell.

The evidence at hand then would seem to indicate a physiopathological rather than an anatomical basis for the appearance of the so called Hurthle cell in the normal thyroid. If this is true, then, the so called Hurthle cell is a phase of the thyroid epithelium and as such does not represent a distinct anatomical unit but rather a functional change, probably nutritive. A similar interpretation probably obtains in the tumors of this cell type. This is supported by the observations of Wegelin who on one occasion noted an area of "large cell adenoma" in the center of an otherwise more usual type of thyroid carcinoma with all stages of transition between the larger and smaller cell types. In another case he found scattered areas of large cell formation in an otherwise usual form of *wuchernde struma* while a metastasis which appeared in the forearm several months later exhibited almost exclusively small alveoli with large oxyphilic cells. Clute and Warren have also noted the similarity between these cells and certain involutionary changes following primary thyroid hyperplasia.

CLASSIFICATION OF HURTHLE CELL TUMOR

Because of all of these essentially anatomical and physiological facts the classification of tumors of the thyroid in general and of the Hurthle cell tumor in particular has always been a difficult and controvertible one, and the number of classifications of thyroid tumors is almost as great as the number of students of thyroid pathology. Langhans' classification made in 1905 is based upon an experience of 36 cases and is as follows:

1. Die wuchernde Struma (adenocarcinoma)
2. Karzinomatöse Struma mit dem gewöhnlichen unregelmässigen Bau der Krebse (ordinary form of carcinoma)
3. Metastasierende Kollindstruma (metastasizing colloid goiter)
4. Parastruma Tumor der Epithelkörper oder Glycogen haltige Struma (Kocher) (Tumors containing excessive amounts of glycogen)
5. Papilloma
6. Kankroid
7. Kleinalveoläre grosszelligen Struma vielleicht Struma postbranchialis (Cetzowa) (Small alveolar large cell tumors [Hurthle type?])

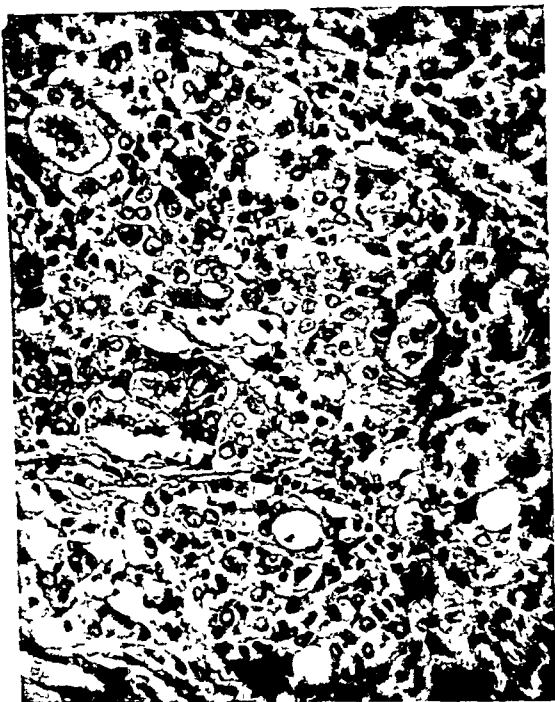


Fig 2 Photomicrograph of section of tumor removed from our case, Case 11. Part of the tissue which might indicate malignant changes $\times 45$

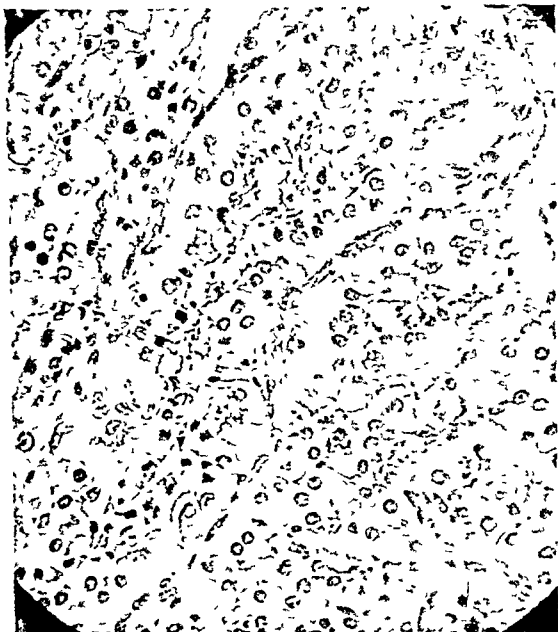


Fig 3 In this photomicrograph which is from the same specimen as is Figure 2, is shown the typical Hurthle cell arrangement $\times 75$

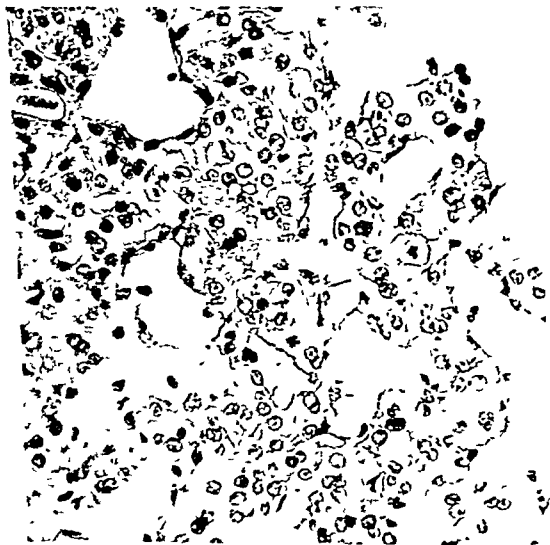


Fig 4 Our case, Case 12, showing the typical characteristics of the Hurthle cell large granular cells with large nuclei $\times 75$



Fig. 5. From same specimen as is Figure 4. In this photomicrograph is shown the pervascular arrangement in the Hurthle cell tumor. $\times 75$.

rather than the two portions of the tumor represent different phases of the same process, which, if carried to completion, might have left behind no clue as to the origin of the larger cell type. Stated in another way our interpretation would suppose that the original stimulus to neoplastic formation engendered a thyroid carcinoma, that, with the growth of this carcinoma, new reactive stimuli were effected in the surrounding tissue, that these reactive stimuli, possibly expressed through changes in the vascular supply to the tumor, in turn affected the tumor resulting in a conversion of the histological appearance from that of the more usual type of adenocarcinoma to the Hurthle cell type, that this conversion is a secondary change which may so involve the entire tumor as to leave behind no trace of the original cell type in some cases, and that this new cell type, now representative of the tumor, is not to be considered a distinct form of tumor any more than is the Hurthle cell in the normal thyroid to be considered a fixed anatomical component of the gland. Furthermore this secondary change to the Hurthle type of cell may occur in tumors which originally may have been either benign or malignant, but following the conversion to the Hurthle cell type this difference may no longer be discernible. Accordingly it is readily understood why tumors formerly grouped under the single heading of Hurthle cell tumors may include both benign and malignant types. It is therefore most urgent, wherever possible to search the tumor carefully for remnants of the original unchanged tumor for a clue as to its real malignancy or benignancy. It is only in this way that we may be able to separate individual tumors with this deceptively characteristic histological appearance into their respective benign and malignant categories, which division is from a clinical viewpoint, the most fundamentally important one in the classification of thyroid tumors.

What is the clinical meaning of this secondary change? We believe that the malignancy is not dependent upon the presence of the so called Hurthle cell, but rather on the malignancy of the underlying tumor upon which is superimposed another factor

(possibly nutritive) which is responsible for the conversion of the tumor cells, already either benign or malignant, to the Hurthle form. That this change may modify some of the properties of the tumor we do not deny. If, as we believe, these cells represent a degenerative change, we can expect some decrease in rapidity of growth, and a slightly more favorable prognosis, a view supported by the relatively benign course of even malignant cases.

TREATMENT

In the present state of our knowledge the primary treatment of these tumors is surgical eradication. It seems better to resect the entire lobe than to enucleate the tumor.

RADIATION THERAPY

Experience with radiation therapy is available in the records of Haagensen's 2 cases and in 1 of ours. Haagensen's cases have gone 7 and 11 years respectively since operation and, according to him, have been definitely benefited by x ray therapy. In our case in which a radium collar was applied the effect so far must be correlated with the failure of any metastatic focus to make its appearance, however, it is much too soon for us to make any definite statement with regard to the permanent result. This experience would tend to indicate the great value of radiation therapy in all cases after the tumor has been surgically eradicated.

SUMMARY

- 1 The origin and significance of the Hurthle cell in normal and neoplastic thyroid tissue is indicated.
- 2 Two thyroid tumors with this distinctive cell are presented and the relationship to thyroid carcinoma demonstrated in one of them.
- 3 At the present state of our knowledge, therefore, we consider it advisable not to place too great an emphasis upon the significance of the so called Hurthle cell type of tumor but rather to separate this group into its component benign and malignant categories upon more fundamental criteria. We suggest that the term Hurthle cell tumor be

CONGENITAL ANOMALIES OF THE RECTUM AND ANUS

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SINCE congenital anomalies of the rectum and anus occur about once in 5,000 newly born babies (3), the average physician will not see a large number of cases. Statistics concerning the frequency of these lesions are extremely variable. Zohrer at the Vienna Lying-In Hospital and Collins in the Dublin Lying-In Hospital jointly report 66,654 deliveries with 3 cases of imperforate anus. These statistics are quoted in Ball's textbook, published in 1887 (1). The Riley Hospital receives children from all sections of the State of Indiana and in the last 12 years there were 34,454 admissions with 22 anomalies of the rectum and anus.¹

The diagnosis of anomaly in this region is not difficult, especially in the serious cases which are associated with, and present symptoms of, acute intestinal obstruction. The difficulty arises in diagnosing the kind of anomaly present so that proper surgical approach may be made.

EMBRYOLOGY

The mesenteron or central portion of the alimentary canal is formed from the entoderm and consists at first of a simple tube which ends blindly anteriorly and posteriorly. This tube represents only the mucous membrane. Later it becomes enveloped in a layer of mesoderm which differentiates into two portions—the outer forming the peritoneal covering while the inner forms the muscle and connective tissue elements. An invagination of ectoderm takes place later at the two ends, anteriorly the stomodeum which constitutes the mouth and posteriorly the proctodeum which constitutes the anal orifice. If we briefly refer to the diagram (Fig. 1) we see that in the 5 weeks embryo the intestine and urogenital sinus empty into a common opening which is known as the cloaca. This condition is nor-

mally present in certain birds and in certain fowls. It is really a caudal expansion of the hind gut which gives off in front of the allantoic stalk (bladder).

At 6 weeks the saddle-like partition between the intestine and the allantois, and known as the urorectal septum, grows caudally, dividing the cloaca into a dorsal rectum and a ventral primitive urogenital sinus. This is complete at about 9 weeks. In the male this latter structure gives rise to the bladder and a greater portion of the urethra, all but the anterior part, and above and posteriorly it receives the mesonephric ducts which later become the vasa deferentia. In the female the muellerian ducts which are derivatives of the aforementioned, later become the uterus and vagina.

The perineum develops by the division of the cloacal membrane into the urogenital membrane in front and the anal membrane behind and by a down growth and spreading out of the mesenchymal elements between these two membranes. At 6 weeks the coccygeal eminence is very prominent and in front of it is a slight elevation surrounded by a groove. From this will develop the anus and generative organs (Fig. 1). At 8 or 9 weeks the anus is separated from the cloacal opening and the perineal septum has begun to form. At 10 weeks determination of sex is possible and the anus is separated from the anterior perineum. This separation is so complete that extravasation of urine is limited to the front of this space and abscesses connected with the rectum seldom invade the front portion. A small pit forms in the perineum (proctodeum) which folds inward until it joins the hind gut. This infolding occurs when the membrane separating them and known as the anal membrane ruptures. This takes place about the eighth week of pregnancy and the point of junction corresponds to what is known as the white line of Hilton in the adult.

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¹The 23d case was in the Coleman Hospital

discarded and that it be replaced by the terms adenoma with Hurthle cell change and adenocarcinoma with Hurthle cell change

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Fig 3 A, Clinical appearance of perineum. Note absence of anus and incomplete development of genitalia. B, Roentgenogram, retouched, showing upside down position. After massage under fluoroscope air pocket was found to descend to a lower level. C, Injection of sodium

iodide into bladder. Note its unusual shape and the abnormal ureters. D, Injection of sodium iodide through recto-urethral fistula into hind gut. E and F, Diagram of recto-urethral fistula before and after operation. Case R-18960 S S.

According to Fraser the congenital malformations of the anus are as follows:

1. Congenital narrowing of the anal canal.
2. Congenital occlusion of the anal canal, by fibrous or membranous tissue, the occlusion being partial or complete.
3. Abnormal location of the anus.
4. Congenital absence of the anus.

Whereas the congenital malformations of the rectum are:

1. Total absence of rectum.
2. Atresia of the lower end of the rectum.

3. Membranous occlusion of the rectum

4. Rectovaginal, recto-urethral and rectovesical fistulas. This classification is accurate anatomically, but does not lend itself well to clinical application because combinations are the rule. A better grouping for practical purposes is the one suggested by Ladd and Gross which is as follows (Fig. 2):

1. Incomplete rupture of the anal membrane or stenosis at a point 1 to 4 centimeters above the anus. Repeated rectal dilatations is all that is necessary.

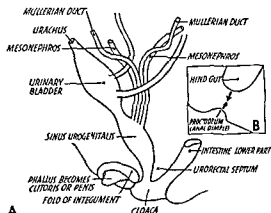


Fig. 1 Diagram of embryological development. Division of the rectum and urogenital diaphragm in the early embryo. Inset: method of inversion of proctodeum and descent of hind gut.

TYPES OF MALFORMATIONS

Most malformations are an arrested development or irregular growth of the proctodeum or the mesenteron. Frequently there is a failure of closure of the perineal septum and then the various forms of fistulas occur. It may readily be seen that anomalies may occur involving the rectum, the anus, the urogenital tract, or any combination of these structures. Many classifications have been advanced to cover all varieties of malformation. Perhaps the most complete and earliest of this group will be found in Ball's textbook.

1. Preternatural narrowing of the anus at the margin, occasionally extending some distance above this point.

2. Complete occlusion of anal aperture by simple membrane or common integument.

3. No anus whatever, the rectum being partially deficient and terminating in a cul de sac at a greater or less distance above its natural outlet.

4. The anus in this variety is normal, the rectum at a variable distance above it being either obstructed by a membrane or completely occluded for a greater or less distance.

5. The anus opens at some part of the perineal or sacral region instead of at its normal position.

6. The rectum opens into the bladder, urethra or vagina, sometimes forming a complete cloaca, the normal anus usually being absent.

7. Rectum normal with the exception that either the ureters, the vagina, or uterus, open preternaturally into it.

8. The rectum is entirely wanting.

9. The rectum and colon both absent. In these cases there is sometimes an opening leading to the intestine at some other part of the surface of the body. It will be seen that in the first three varieties the development of the proctodeum is principally at fault, while in the others the malformation is of a more complicated character.

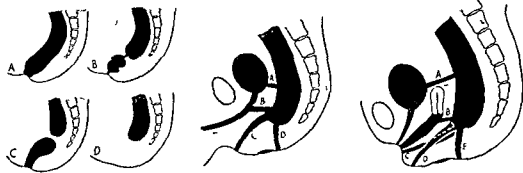


Fig. 2 Left four types of anomalies which have been encountered.

Center types of fistulas in male (A) rectovesical (B) recto-urethral (C) rectoperineal.

Right types of fistulas in female (A) rectovesical (B) rectovaginal (C) rectofossa navicularis and rectofourchette (D) rectoperineal (Modified from Ladd and Gross loc. cit.)

fetal enteritis (4) may be the cause. One thing is definitely known—that these anomalies usually do not occur singly and this must be borne in mind in prognosis and treatment.

SYMPTOMS OF ANOMALIES

The symptoms of most of these patients are those of acute intestinal obstruction. Sometimes there is partial intestinal obstruction with distention and in the fistulous types parents will note that there is an abnormal opening with an absence or occlusion of the anus. Further discussion is unnecessary for diagnosis is made easily when the possibility of these congenital anomalies is considered.

DIAGNOSIS OF TYPES

The chief concern of the surgeon is the accurate diagnosis of the type anomaly that exists. In order to establish this many methods are used, such as:

1. X-ray examination of the abdomen with the child in the upside down position (9). The rationale for this is the hope that gas in the obstructed hind gut will rise to the top or dome of the obstruction, thereby revealing its proximity to the anal canal. This method is a very useful one, but leads to errors in diagnosis during the first 24 hours of life because gas is rarely present beyond the hepatic flexure (Fig 3).

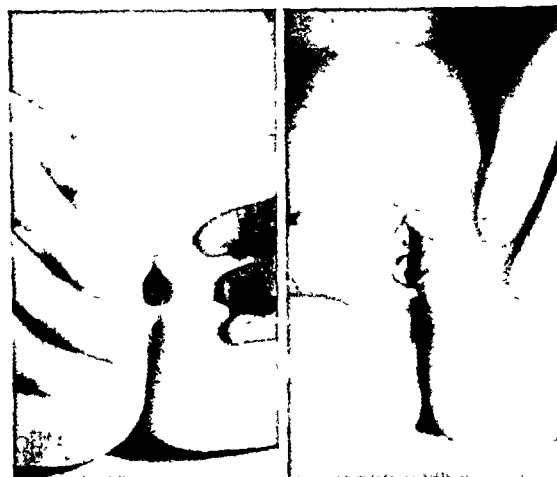


Fig 6 A, Photograph of anomaly present. Note the rectofossa navicularis fistula (retouched). B, After operation. Note double vagina and reconstructed perineum. Case C-R-5583. J. R.

2. Injection of 12½ per cent sodium iodide when there is an external fistula (Fig 3); this should be done also to reveal internal fistulas.

3. Performance of a colostomy with digital examination of the blind hind gut. This method is fraught with danger because the mortality in this group is extremely high (some figures up to 90 per cent).

4. We have recently used the fluoroscope as an aid in diagnosis, especially in the first

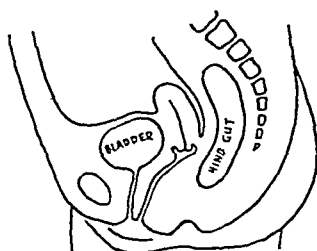


Fig 7

Fig 7 Diagram of imperforate anus, group IV. Case R-12224. V. G.

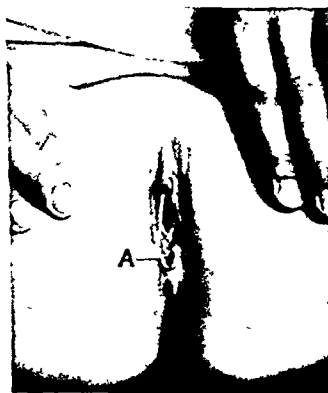


Fig 8

Fig 8 Photograph of rectofourchette fistula before operation. Case R-2736. N. S.

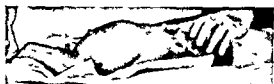


Fig 9

Fig 9 Photograph of rectoperineal fistula. Note persistence of genital tubercles or swellings. Case R-19119. G. R.



A

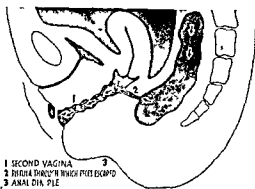


B

2 Imperforate anus or obstruction due only to a persistent membrane. Cruciate incisions followed by dilatations is all that is necessary.

3 Imperforate anus with rectal pouch separate from anal membrane. (Most frequently encountered anomaly.) Perineal incision is required and rectal pouch should be brought down to anal sphincter.

4 Anus and anal pouch normal, but rectal pouch ending blindly. Most difficult to treat because the rectal pouch is so high that it is difficult to reach through perineal approach, mortality, 61.6 per cent.



C

Fig 4 A Before operation. Note enormous distention. B After operation. C Diagram indicating anomaly encountered. Rectovaginal fistula running between septum in double vagina. Case R 15694. A. H. K.

If now we add to this classification the various types of fistulas we have a satisfactory clinical grouping. By referring to the embryological review we may readily understand why in the male there may be rectovesical, rectourethral, or rectoperineal fistulas, whereas in the female there may be rectovesical but more commonly rectovaginal or rectovulvar or rectoperineal fistulas (Fig 2).

CAUSE OF ANOMALIES

The cause of these anomalies is of course, a matter of conjecture. Some say it is apt to occur in families (6). Others have said fetal peritonitis or chorionic adhesions as well as

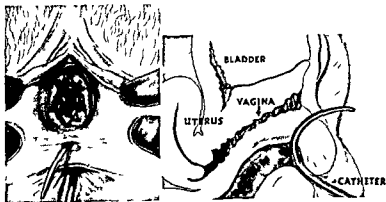


Fig 5 A Diagram showing rectoperineal fistula. Sphincteric action present in both openings. B Diagram of cross section.

TABLE I.—ASSOCIATED ANOMALIES

Heart	
Patent ductus arteriosus	2
Patent foramen ovale	1
Congenital heart lesion, type not classified	1
Arteries	
Congenital atresia of right iliac	1
Lungs	
Congenital atelectasis, left lung	1
Genito-urinary tract	
Double vagina	2
Cryptorchidism	1
Anomaly of bladder and ureter	2
Absence of the left kidney	1
Gastro-intestinal tract	
Meckel's diverticulum	1
Congenital malformation of ileum	1
Abdominal wall	
Umbilical hernia	2
Feet	
Bilateral club feet	1
Brain	
Mongolian idiocy	1
Spine	
Spina bifida occulta	1
Congenital partial absence of lumbar vertebra	1
Eyes	
Strabismus	1
2 children had 2 anomalies each	
2 children had 4 anomalies each	
The 9 remaining children had 1 anomaly each	
Total cases having anomalies (56.5%)	13

TABLE II.—TREATMENT AND RESULTS

Group	Medical			
	Results			
	Recovered	Died	Improved	Unimproved
I—1		1		
II				
III				
IV—1		1		
V—3		1		2
Total—5		3		2

Group	Surgical			
	Results			
	Recovered	Died	Improved	Unimproved
I—1	1			
II—2	1	1		
III—2			2 (Colostomy)	
IV—2	1	1		
V—11	10	1		
Total—18	13	3	2	

Deaths in hospital (medical and surgical)

Deaths after leaving hospital (medical and surgical)

Total deaths (medical and surgical)

6

5

11

brought down to the skin, a hollow needle is inserted to make sure of the structure and then a cross incision is made and the mucous membrane sewed to the skin in a position corresponding approximately to the anal sphincter. Chromic catgut No. 0 is used to suture the bowel to the skin as well as to close the incision.

4 If a fistula is present, it should be left alone until the child is older. This is done because attempts to close them at the time of operation fails in half the cases and increases the mortality. In older children fistulas may be closed if accessible, but if in the bladder closure should be deferred until the child is much older, also, fistulas sometimes, although very rarely, will close spontaneously after the rectal opening is re-established. If the child is unable to stand any surgery, then simple dilatation of the fistula may be used temporarily.

SUMMARY OF CASES

Of the 23 cases, there were 12 males and 11 females. One of doubtful sex (Fig. 3) was thought to be a female, but diagnosed a male because of structures which felt like testes in

the genital folds and a urethra which traversed the genital tubercle. So far as I am able to ascertain the urethra has never been reported in the clitoris.

Six were in the newborn, 10 under 1 year, 4 between the ages of 1 and 5 years, and 3 over 5 years of age.

Fourteen had associated fistulas, 9 did not. Following our grouping there were 2 in group 1; 2 in group 2, 2 in group 3; 3 in group 4, and 14 (60 per cent) in group 5.

Thirteen (56.5 per cent) of these patients had associated anomalies. Two of these had four present. Nature does not err singly in most cases (Table I).

Five patients were treated by palliation or were *in extremis* before surgical treatment could be instituted. Of this group 3 died and 2 were unimproved, a mortality of 60 per cent.

Eighteen were treated surgically. There were 3 deaths in this group and an operative mortality of 6.6 per cent. A follow-up study

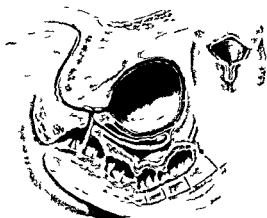


Fig 10 Diagram illustrating stones in the neck of the bladder and rectovesical fistula with diverticulum containing a urinary calculus Case R 18,8 D D

24 hours of life The infant may be moved in various positions and by gentle massage of the abdomen gas is forced down or up into the blind hind gut The position is then marked by bony landmarks or by metal arrows fastened to the skin by adhesive Thus far we have had no inaccurate diagnosis by this method¹ The fluoroscope often reveals co-existent anomalies by demonstrating pockets of gas which cannot be shifted from one portion of the intestine to another

TREATMENT

Treatment obviously varies with the type anomaly and the age of the child We may

¹The author is indebted to Dr Wright of our x-ray department for his aid in developing this procedure

dogmatically state the following rules concerning treatment

1 All treatment depends upon accurate diagnosis

2 Avoid colostomy whenever possible Mortality in this group is high, especially in the newborn

3 Dissections should be made from below by making a longitudinal incision from the middle of the perineal body posteriorly to the coccyx, thereby cutting directly through the sphincter Since the external anal sphincter muscle develops from regional mesenchyma and is not dependent upon the presence of the terminal bowel it is practically always present This accounts for good sphincteric control in patients operated upon for congenital absence of anus The rectum descends in the hollow of the sacrum closely applied to that bone and except at its upper part is uncovered by perineum posteriorly In front the perineal pouch descends to a much lower level while its close relations to the genito-urinary organs should be borne in mind Dissection should then be carried upward hugging the coccyx and the hollow of the sacrum, staying in the midline Extreme gentleness and care are necessary until a structure resembling membrane is encountered since this may be peritoneum it should be gently pushed back anteriorly The operation is carried on under local anesthesia in the newborn, and as the baby cries and strains the hind gut is seen to bulge into the field of operation After mobilization is complete the hind gut is



Fig 11 Left and center infant 6 weeks old with rectofourchette fistula before operation Right case of rectofossa navicularis fistula in an infant 3 months of age 5 weeks after perineal operation

R-5149, D. L. D., male, aged 2 days; full-term child, breech delivery, birth weight $7\frac{1}{2}$ pounds. The parents noted that the baby had no bowel movements and that he vomited. Physician made diagnosis of imperforate anus and the child was admitted to Riley Hospital on January 24, 1933. He was operated upon immediately. Skin incision was made through the approximate site of the anus. Tissues were dissected back, and the sac of the hind gut was exposed. This was opened and sutured to the skin margins forming an anus. Much meconium was passed. The infant did well for a period of 4 days after operation when he suddenly became cyanotic and physical and x-ray examination definitely determined that there was a partial collapse of the left lung field, diagnosed as atelectasis neonatorum. Oxygen therapy was instituted; however the patient died on January 31, 1933. Post-mortem examination disclosed imperforate anus, Meckel's diverticulum, and atelectasis of left lung.

GROUP IV

Ball: Anus normal, rectum at a variable distance above obstructed by membrane or completely occluded for a greater or less distance.

Ladd and Gross. Anus and anal pouch normal. Rectal pouch ending blindly.

R-12224, J. G., female, aged 2 days, normal delivery, full-term baby, birth weight 8 pounds. Mother noticed that the patient did not have a bowel movement and the physician made the diagnosis of imperforate anus and referred the child to the Riley Hospital. Admission was February 17, 1935. A dimple was found about the region of the anal orifice and a slight protrusion was noticed when the baby cried. Incision was made in this area and with blunt dissection the subcutaneous tissue was pushed back with a hemostat until the hind gut was reached which was approximately 2 centimeters from the skin. The hind gut was opened at which time a large amount of gas and meconium was expelled. The hind gut was loosened and pulled down with four clamps. It was then sutured to the skin with interrupted plain catgut No. 1 sutures. No anesthesia was used and the patient was in good condition following operation. On April 13, 1935, patient was readmitted. Diagnosis of scar tissue contracture resulting in imperforate anus was made. After repeated dilatations the patient was discharged on April 13, 1935, in an improved condition. Associated anomalies mongolian idiocy. (See Fig. 7.)

R-16305, M. E. J., male, aged 2 days, admitted May 20, 1936. Shortly after birth, which was a breech presentation, the child began to vomit. Vomiting was projectile in type and stercoraceous in character. There had been no stools. The baby was cyanotic and the abdomen markedly distended. A slight anal dimple was found, but there was com-

plete atresia of the rectum. X-ray examination showed the hind gut to be a short distance above the occluded anus. The child was immediately transfused, he received 70 cubic centimeters of citrated blood. However, before the child could be prepared for surgery, he died and an autopsy was obtained. This revealed a congenital atresia of the anus and descending colon at the rectosigmoid junction, and an occlusion of the hind gut. Associated anomalies: patent ductus arteriosus, patent foramen ovale, cryptorchidism, bilateral

GROUP V

Ball: Rectum opens into bladder, urethra or vagina sometimes forming a complete cloaca, the normal anus usually being absent or

Author: Fistulas in combination with any of previous groups. Most common type of anomaly in our series.

R-6441, M. P., male, aged 10 years, premature child 8 months, weight 5 pounds. Diagnosis of imperforate anus made at birth and perineal operation performed at 30 hours bringing hind gut down to anal orifice with recovery. Child's mother noticed bluish discoloration of the nails at 5 weeks and a congenital heart lesion was demonstrated at this time. At 6 months feces was seen to come through penis. Child was next seen at the age of 4, and a definite rectovesical fistula was demonstrated. Now at the age of 10 sphincteric control is present although not strong. Urine occasionally is loaded with pus and *Bacillus coli* demonstrated but soon cleared up after bladder irrigations. Congenital heart lesion present, since bladder condition was controllable, no further surgery was done. Child has been a cardiac invalid. Last seen April 17, 1937.

R-1878 D. D., aged 2 years, male, was born without anal opening. At 26 days a perineal operation was done elsewhere and the rectum brought down to the skin. At 1 year of age a colostomy was attempted elsewhere. However, the small bowel was entered and an enterostomy was performed instead. This soon closed. On admission to the Riley Hospital on April 19, 1932, the child was found to have a small anal opening with no sphincteric control, and in addition a rectovesical fistula. The urine was contaminated with fecal matter. Cystoscopic examination was done on May 26, 1932, and kidney, ureter, bladder plate showed the presence of multiple calculi in the urinary bladder. Intravenous pyelogram revealed dilatation of the right ureter and apparently no functioning of the left kidney. X-ray plates of the lumbosacral spine showed a spina bifida occulta of the first two sacral segments. Retrograde cystogram disclosed a definite fistulous tract between the bladder and the rectum. Surgery on June 23, 1932, was as follows: "Midline incision extending from pubis well up toward the umbilicus. Fascia divided and bladder exposed by blunt finger

of these cases showed that 5 others had died since their release from the hospital

This brings the total deaths to 11 or 47.8 per cent over a period of 12 years (Table II). In 8 (72.8 per cent) of these deaths associated anomalies were present which accounted for their demise.

GROUP I

Ball Preternatural narrowing of anus at margin occasionally extending some distance above this point

Ladd and Gross Incomplete rupture of anal membrane or stenosis at a point 1 to 4 centimeters above the anus

R 5383 L. G. male aged 4 years full term baby. At 1 month his weight was 6 pounds. The child had attacks of colic which persisted as severe abdominal cramp like pains. He had infantile paralysis at 2½ year of age. There was no control of bowel action. Diagnosis of Hirschsprung's disease was made elsewhere. Our examination showed a constriction of the anus about 3½ inch above the external sphincter. This was hard and unyielding, with fecal impaction above. On October 3, 1933, the stricture was divided by cauterization and followed by repeated dilatations. Last seen on May 7, 1935 when anus was open and there was no fecal impaction. The mother was instructed to continue dilatation.

R 9191 R. D. D. male aged 2 months full term normal delivery birth weight 8¼ pounds. At 3 weeks of age he had projectile vomiting. He was given a formula and atropine which helped some but he lost weight. He was admitted to Riley Hospital on August 29, 1934 with diagnosis of imperforate anus (group I), bilateral club feet and deformity of the back. Treatment was symptomatic and supportive but his condition became progressively worse and he died on September 16, 1934. Postmortem examination disclosed congenital partial absence of vertebrae, talipes equinovarus, imperforate anus, absence of left kidney, acute suppurative otitis media, acute mastoiditis, infectious gastroenteritis and Bacillus coli septicemia.

GROUP II

Ball Complete occlusion of the anal aperture by simple membrane or by common integument

Ladd and Gross Imperforate anus or obstruction due only to persistent membrane

R 7915 B. J. H. male aged 17 months full term baby. An imperforate anus was discovered at birth. The anal membrane was opened and the stricture was dilated on four occasions. On January 15, 1934 a perirectal abscess was drained which left a fistula

in ano. No further surgery was done and no further symptoms were reported. On March 19, 1934 the child was readmitted to the hospital with the diagnosis of chronic otitis media and mastoiditis. A mastoidectomy was done. Child died April 8, 1934 of infectious diarrhea. No associated anomalies.

R 13595 C. L. female aged 3 days premature birth. Soon after birth the physician noted an imperforate anus with marked distention. Upon admission to the Riley Hospital on July 24, 1935 the distention was very marked and the child was not voiding. She was vomiting and her condition was very critical. She was placed in the oxygen chamber and was given fluids subcutaneously. A small incision was made through the anus and a large quantity of gas escaped through the tube. No further operative procedure was done because of the critical condition of the patient. She died on July 25, 1935. No postmortem examination was made. Associated anomalies were in the urinary tract.

GROUP III

Ball No anus whatever the rectum being partially deficient and terminating in a cul de sac at a greater or less distance above its normal outlet

Ladd and Gross Imperforate anus with rectal pouch separate from anal membrane

R 10895 L. A. male aged 17 months full term baby, birth weight 8¼ pounds. Forty eight hours after birth it was noted that there was a congenital absence of the anus. The child was taken to the hospital immediately (elsewhere) and operated upon. Colostomy was performed and following surgery the child improved. He was admitted to the Riley Hospital on October 2, 1934. Diagnosis of imperforate anus was made. A ray examination with barium showed good filling of the large intestines to the level of the colostomy, but no barium went below this area. A ray did not demonstrate a sigmoid or rectum near the normal location. The child was sent home on October 31, 1934 and was readmitted on April 23, 1935 for surgery but this procedure was not done because the ward was isolated for scarlet fever. He was furloughed on May 8, 1935 to return in 3 weeks. However he was not brought back at that time. Associated anomalies none.

R 13986 J. W. male aged 3 months full term infant weight 8 pounds 11 ounces breech extraction. At birth the physician noted that there was a congenital absence of the anus. The baby was operated upon July 6 elsewhere and a colostomy was done. He was admitted to the Riley Hospital on September 14, 1934. Upon admission the child was markedly dehydrated and the only treatment was repeated blood transfusions which were unavailable. The child died on September 23, 1934. Diagnosis imperforate anus with rectal pouch separate from the anal membrane. Associated anomalies patent ductus arteriosus.

R-5149, D. L. D., male, aged 2 days; full-term child, breech delivery; birth weight 7½ pounds. The parents noted that the baby had no bowel movements and that he vomited. Physician made diagnosis of imperforate anus and the child was admitted to Riley Hospital on January 24, 1933. He was operated upon immediately. Skin incision was made through the approximate site of the anus. Tissues were dissected back, and the sac of the hind gut was exposed. This was opened and sutured to the skin margins forming an anus. Much meconium was passed. The infant did well for a period of 4 days after operation when he suddenly became cyanotic and physical and x-ray examination definitely determined that there was a partial collapse of the left lung field, diagnosed as atelectasis neonatorum. Oxygen therapy was instituted, however the patient died on January 31, 1933. Post-mortem examination disclosed imperforate anus, Meckel's diverticulum, and atelectasis of left lung.

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plete atresia of the rectum. X-ray examination showed the hind gut to be a short distance above the occluded anus. The child was immediately transfused, he received 70 cubic centimeters of citrated blood. However, before the child could be prepared for surgery, he died and an autopsy was obtained. This revealed a congenital atresia of the anus and descending colon at the rectosigmoid junction, and an occlusion of the hind gut. Associated anomalies: patent ductus arteriosus, patent foramen ovale, cryptorchidism, bilateral

GROUP V

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dissection Bladder opened and two stones removed from the posterior urethra A third stone was not found in the bladder It was located outside of the bladder cavity Its size was approximately 1 by $\frac{3}{4}$ inch freely movable and could be felt from within the bladder wall on any side and could be brought down to neck of the bladder It was smooth and flat on one side The bladder was freed on the left but the stone was not attached in this region On rectal examination the stone could also be felt outside the gut and outside the bladder The bladder was anchored to the abdomen with silk, a piece of gauze was inserted above and below and a Pezzer siphon tube was anchored in the bladder The skin was closed with silk worm gut Patient left the operating room in good condition Proctoscopic examination revealed a small fistulous tract about 1 inch above the strictured area in the rectum The stricture was dilated and the child was dismissed on August 19, 1932, to return for future dilatations It was felt that the child would not be benefited by surgical closure of the fistulous tract at this time Follow up disclosed that the child died in 1937 An autopsy revealed congenital atresia of the rectum rectovesical fistula and a stone in a diverticulum of the fistulous tract (Fig 10)

RECTOVAGINAL FISTULA

R 1569, A H K female aged 7 weeks full term baby of syphilitic mother—three siblings (2 still born 1 died at 1 week) 1 miscarriage When 7 weeks old there was an enormous abdominal distention general emaciation but no vomiting Diagnosis imperforate anus re- to aginal fistula Operation was done March 18, 1936 Hind gut was brought down to the skin through a perineal incision after perineum was divided Double vagina was divided and the perineum reconstructed Recovery followed operation Repeated dilatations were done Last seen November 22, 1936 Good progress had been made On December 13, 1936 seen by Dr K. of Laporte, when there was obstruction due to intussusception at the iliocecal valve Baby died before surgery could be instituted (Fig 4)

R 1507 J A G female aged 6 weeks slightly premature normal delivery birth weight 6½ pounds On the day after birth it was noted that the bowel movement was through the vagina An anal dimple was present but there was no opening Baby was in good nutritional state upon admission on December 17, 1935 Diagnosis was imperforate anus and congenital rectovaginal fistula No surgery was attempted because of the infant's poor condition and treatment was supportive and symptomatic Patient gradually grew worse and died on April 10, 1936 Postmortem examination showed bronchopneumonia otitis media congenital imperforate anus and rectovaginal fistula

R 1662 M A female aged 4 months born August 20, 1930 full term, normal delivery On the second day after birth the mother noticed that the child had had no bowel movement and examination

of the perineum revealed that no anus was present A small amount of fecal matter was coming through the vagina The family doctor then dilated the rectovaginal fistula and the baby managed to thrive with the condition until admission to the Riley Hospital on December 14, 1930 Diagnosis in the hospital was rectovaginal fistula with congenital absence of anus On April 15, 1931, under ether anesthesia perineal incision was made the vaginal canal and bowel opening identified and the rectum dissected away from the vaginal floor A muscular band was found just below the fourchet which had the resemblance of sphincter fibers With blunt dissection an opening at the approximate site of the anus was made and the rectum brought down through this and sutured to the cutaneous margin with plain catgut No 0 The skin incision and lower part of the vaginal floor were closed with interrupted sutures of plain catgut No 0 Following this operation the sutures pulled out and a second operation was done on April 21, 1931 Rectum was again brought down to the new opening made at the first operation and anchored with continuous sutures of black silk interrupted at three places Vaginal mucosa was anchored at the cutaneous margin with interrupted sutures of plain catgut No 0 Following this procedure repeated rectal dilatations were done The patient was discharged on June 12, 1931 and was last seen on June 25, 1934 with marked improvement No associated anomalies were recorded

R 5242, M McC female aged 7 months normal delivery Shortly after birth attending physician noted the absence of an anus and that fecal matter was exuding from the vagina The patient seemed to thrive in spite of this anomaly until February 4, 1933 when she was admitted to the Peley Hospital because of distention Our diagnosis was congenital narrowing of the anus with rectovaginal fistula Repeated dilatations were done and the patient made a satisfactory recovery Last seen in the out patient department on February 17, 1936 with satisfactory progress noted

R 3156 G C female aged 7 months full term normal delivery At birth physician noted that the anus was imperforate and that fecal matter exuded from the vagina The fistulous tract was dilated and the child seemed to thrive until her admission to the Riley Hospital on April 25, 1937 with bronchopneumonia No operative procedure was done except for dilatation of the rectovaginal fistula The parents were asked to return the child for surgery at a later date but this has not been done therefore the present status of the child is unknown A letter received November 8, 1937 reported that she had been feeling well and was gaining weight and that the family had moved to Illinois

RECTOVAGINAL AND RECTO URETHRAL FISTULA

R 15092 J M S, female aged 6 months full term baby No abnormality was noted by physician at birth When 8 days old mother noted bowel ac

tion through vagina and absence of anus Insertion of two opaque catheters and injection of opaque media showed the posterior catheter to lead into the rectum and the anterior catheter into a small bladder. There was then a recto-urethral as well as recto-vaginal fistula, but the latter was much larger and all fecal matter discharged through it No treatment was done by staff at this time A small umbilical hernia was present Last seen April 27, 1936, in good condition

RECTOVAGINAL AND RECTOPERINEAL FISTULA

C-8656, S. U., female, aged 19 years Patient was seen in Prenatal Clinic at the Coleman Hospital where general physical examination had failed to disclose the congenital malformation of the rectum She was admitted to the hospital on December 21, 1935, in labor. On admission it was noted that rectal examination was impossible because the rectal opening was too small to admit a finger She was allowed to continue in labor, and after 15 hours the head was no farther than mid-pelvis by abdominal examination. Vaginal examination was therefore done and disclosed that the middle finger accidentally entered an unseen opening and the index finger entered the vagina. Closer examination revealed this opening to be about midway between the hymenal ring and the true anus, and easily admitted a finger There was a moderate degree of sphincter action about this opening Previous to this nurses had reported that rectal ether, which had been given through a catheter into the rectum through the anus, had come out of the vagina The anomalous opening was invisible to ordinary examination due to the peculiar way in which the mucous membrane was overlapped and folded Further history at this time revealed that the patient had been born with a very small anal opening At 1 year of age excision of the fistula was attempted elsewhere A few days after operation, however, the stitches had torn loose and since that time no treatment had been instituted. Patient was delivered by cesarean section No treatment of fistula done at this time The patient has not been seen since her discharge from the hospital.

This demonstrates that sphincteric action is possible even when the rectum is not situated in the normal position (Fig. 5).

RECTOVAGINAL (FOSSA NAVICULARIS) FISTULA

R-5583, J. R., female, aged 9 years, full-term, normal delivery Malformation was first noted when child was 5 months of age, but she was not ill up to the time of admission to the Riley Hospital on February 24, 1930 Diagnosis imperforate anus, rectovaginal fistula, hydrocephalus After consultations and examination it was decided to readmit the child in 1 year for operation if her condition warranted it, and the hydrocephalus had not increased. She was readmitted on March 20, 1933, having had no disease, except pertussis, since the last admission She was again furloughed without operation, but

was readmitted on April 13, 1937, at age of 7 years. She was operated upon April 29, 1937. Incision was made in the region of the anal dimple. The hind gut was found to extend into the fossa navicularis. A transverse incision was made freeing this portion of the vagina together with the hind gut. This structure was then anchored to the skin in the normal position of the anus. The perineum was then reconstructed The child was found to have a double vagina, also. Following surgery the enormous fecal impaction was released by using peroxide irrigations Associated anomalies: cross eyes, double vagina (Fig. 6).

RECTOVAGINAL (FOURCHETTE) FISTULA

R-2736, N. S., female, aged 9 years Soon after birth it was noted that the child had a small opening just posterior to the fourchette (frenulum labiorum pudendi) A small amount of fecal matter was seen to exude at this point which was anterior to the rectal sphincter. The patient was operated upon (elsewhere) and simple dilatation of the fistula was done. On August 31, 1936, the patient was operated upon at the Riley Hospital by the perineal route, and the hind gut was brought down to the skin margin. On September 15, 1936, the fistula was excised but later recurred Following this the patient had repeated rectal dilatations. When she was last heard from the rectofourchette fistula was still present, but the newly formed anus was functioning with good sphincteric control (Fig. 8).

RECTO-URETHRAL FISTULA

R-5423, P. S., male, aged 12 hours; full-term baby Child was brought to the Riley Hospital because of an imperforate anus, and was operated upon March 2, 1933 Through a perineal incision the blind hind gut was brought down to the skin and anchored with interrupted silk sutures The child passed meconium, but expired on March 4, 1933. Postmortem was obtained with the findings of imperforate anus, recto-urethral fistula, congenital atresia of the right iliac artery.

R-18960, S. S., female (?), aged 1 day; full-term baby, normal delivery, weight 7 pounds. Physician noted at birth the absence of an anus and malformed genitals. Numerous roentgenograms, including sodium iodide injection, revealed absence of anus, blind hind gut with a recto-urethral fistula The child was operated upon March 12, 1937, by perineal section The blind hind gut was identified, found $1\frac{1}{4}$ inch from the skin margin. It was carefully mobilized, brought down to the skin, opened, and the free edges were sewed to the skin with interrupted plain catgut No ∞ sutures. The hind gut was then flushed with normal saline solution and a large amount of meconium was recovered The child made an uneventful recovery, and after several manual dilatations he was dismissed from the hospital in good condition on April 28, 1937 Before the baby left the hospital several urinalyses were made and the genito-urinary department was

asked to see the child. The abnormal ureters and bladder indicated clearly the congenital malformation of the urinary tract with infection. However no treatment was instituted at this time. On May 1, 1937, a letter was received from the physician stating that the baby had died from possible urinary infection. Associated anomalies were in the genito-urinary tract (Fig. 3).

R 19119 G R., male aged 9 weeks full term child normal delivery entered the Riley Hospital on March 29, 1937. The complaint was inability to have normal stools and the presence of a skin tab about the rectum. Diagnosis was incomplete rupture of the rectal membrane with a stenosis, together with a congenital failure of the proctodeum to invert. At operation the hind gut was found to be constricted and to have several small openings which formed draining sinuses about the constricted anus. The operative procedure was as follows: The area around the small sinuses was excised dissecting in ward approximately 5 centimeters where the hind gut was entered and a large amount of hard fecal material was expelled by the patient. The colon was then irrigated thoroughly and the hind gut was sutured to the skin giving a good external opening. Associated anomalies none (Fig. 9).

CONCLUSIONS

1. A study of 23 cases of congenital anomalies of the rectum and anus has been made and a brief summary of each case is recorded. This type of anomaly is rare.

2. In over 56 per cent of these cases there were one or more associated anomalies. This

Since submitting this paper for publication we have treated 3 more cases. One with narrowing of anus and rectum for a distance of 1 1/2 in. (Gro. p 1). A girl aged 3 years who complained of partial fecal incontinence. She had an enormously distended sigmoid flexure for 1 1/2 in. After 2 days of treatment with enemas and cathartics the rectum was opened and the sigmoid was removed. The patient is doing well with complete recovery (Fig. 1). On female infant aged 6 weeks with ectofoveollette fistula (Group V) having perineal operation with complete recovery. The latter 2 cases were associated with congenital absence of the anus.

proves the wisdom of an old aphorism "If you find one congenital anomaly search for others."

3. The simplest classification is the combined clinical one as suggested.

4. It is necessary to make a careful study of the type anomaly so that correct treatment may be applied. The aid of the fluoroscope in the newborn is described.

5. A study of the various methods of treatment and their results leads one to conclude that early perineal operation is the method of choice.

6. Sphincteric action may be obtained even if the hind gut is not implanted within the anal sphincter or if this sphincter is absent.

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THE USE OF OS PURUM IN BONE IMPLANTATIONS

With Special Reference to Its Use in Tuberculous Bone and Joint Lesions

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IN MY thesis published in 1934,¹ I reported the results of some investigations I had made on the treatment of tuberculous spondylitis, in which small pieces of bone were implanted in the wound over the tibia during the performance of operations to obtain fresh bone for spinal fusions according to Albee's technique. The implanted pieces of bone were removed for gross and microscopic examination after varying periods of time. Repeated x-ray pictures were also taken of the pieces of bone while they still lay in the tissues.

By these investigations, I was able to show that if a fresh autoplasmic bone transplant were laid subcutaneously, and another were boiled and laid subperiosteally upon the tibia, newly formed bone tissue would be found in the same degree in both at the end of 14 days. This demonstrated that skeletal connective tissue (represented by periosteum, endosteum, and connective tissue in the haversian canals) in or about the transplant is of fundamental importance for new bone formation. When natural nourishment is restored to the bone tissue in the fresh pieces of bone, it is able to revive and build new bone tissue just as rapidly as the skeletal connective tissue of the tibia is capable of forming bone.

The subperiosteally implanted, fresh, autoplasmic pieces of bone behave, therefore, in much the same manner as boiled pieces of bone. Boiled and dried pieces of bone, which have been prepared for some time prior to implantation, are replaced by new bone considerably more slowly, and they are probably sometimes not resorbed at all but produce so-called *tole Einheilung*.

In implantation of bone in the skeleton, one should therefore use bone in such form and in

such manner that the skeletal connective tissue in it can quickly revive, and that the living skeletal connective tissue in the compact bone in the bed of the implant may grow into the canal system of the implant as easily and as quickly as possible. To fulfill the first qualification, fresh autoplasmic bone is most ideal; to fulfill the second, bone which I have called "os purum," and which is prepared in a special manner, is nearest ideal.

In the canal system of boiled and dried bone which has been stored for a time, resorption and new bone formation occur considerably more slowly after implantation than in the case of fresh bone or freshly boiled bone, probably because the coagulated and dried up connective tissue, and the collagen converted to glue, must first be resorbed before the connective tissue cells can grow into the canals and react upon the hard calcified material. Such dried bone therefore should not be used for clinical transplantation of bone. In order to obtain material satisfactory from all standpoints, "os purum" has been developed. By means of a physicochemical method of preparation, ordinary bone has been freed as completely as possible of connective tissue, fat, and protein foreign to the host, and the calcified substance made as clean as possible without injuring its mechanical strength. The complicated and time-consuming method of preparation consists chiefly of the removal of the blood proteins by soaking in salt solution, the connective tissue by soaking in warm potassium hydroxide, and the fat by soaking in acetone.

Fresh autoplasmic bone material has long been used as a routine method in surgical transplantation of bone (see especially Olliers, Axhausen, Lexer, and Albee). This method has its limits, however, since such bone transplants are taken from the skeleton of the patient's own body. The bone transplants are therefore limited in size and shape and are

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¹Orell, Svante. Studien ueber Knochenimplantation und Knochenneubildung. Implantation von "Os purum" sowie Transplantation von "Os rovim." Acta Chir. Scand., 1934, 74; Suppl. 31.

only slightly variable, and since it is desired also that a portion of the cells survive and take part in the new bone formation, the transplant cannot be handled freely during preparation, but must be treated with the greatest respect.

Barth's theories on this subject dominated the field from 1893 to the time of Axhausen's work in 1908. His theories, based on the microscopic examination of transplants, maintained that the bony substance dies in its entirety and that sterile preserved bone might as well, therefore, be used in bone transplantations. Barth himself used *gegluhter Knochen*, bone which was freed of organic substance by burning. These experiments produced no great progress, probably because in burning the bone, animal charcoal and salts remain in the canals to prevent, or at least to hinder, the ingrowth of living cells from the bed of the transplant. Moreover, the glue resulting from the high degree of heating, becomes insoluble.

Bone fixed in either alcohol or formalin was often used. After fixation it becomes very difficult if not impossible for the cells and the tissue juices in the bed of the implant to resorb the tissues in the implant. Tissues hardened in alcohol or formalin can, as a matter of fact, scarcely be digested even by stomach juices. By boiling and drying the bone, the connective tissue and protein material in the canals are coagulated, as mentioned, and the cells in the bed must first react upon these substances and resorb them before they can reach the bone calcium. This resorption of connective tissue in the canals was first suggested by Marchand in 1900, but had not led to the introduction of any practical measures.

Axhausen (1908), however, was responsible for an entirely different conception. He emphasized the superiority of fresh autoplasic bone transplants, and again as Ollier had previously done, demonstrated the importance of the periosteum in the process of new bone formation after transplantation. Sterilized bone, it is true, has since been used as nails, pegs, screws, bridges, planks, etc., in osteosynthesis, but in transplantations in which the main success of the transplants depended chiefly upon the union of the transplant with the skeleton, fresh bone material

has chiefly been used. As a result of more recent investigations, however, it is perhaps now permissible to carry out certain surgical implantations with the aid of *os purum*, especially since such material offers considerable technical advantages.

I have used the implantation of *os purum* to replace bone which for some reason or other has been resected, most often for tuberculosis. It has been used to fill up the bone defects which result from operation to lessen the chance of producing deformities, and to fix the parts of the skeleton in proper relation to one another in various ways, often after replacing, reshaping or changing the position of them. Many of the patients with implants of *os purum* have now been followed for 4 or 5 years. The wounds have, as a rule, healed without complications, and the implants have shown sufficient strength for their mechanical task until they have gradually been rebuilt and replaced by new bone.

In reporting the following series of cases in which *os purum* has been used, a review will first be made of 3 cases of tuberculous osteitis which were previously described in my thesis. They are included here in order to give the end results at recent follow up examinations. In Case 1 were noted good healing and rebuilding after a resection in which *os purum* was implanted in the diaphysis.

In Case 2 is demonstrated the fact that the implanted *os purum*, just as fresh autoplasic bone is rebuilt to perfectly satisfactory form in spite of the fact that the periosteum of the bed has been damaged through suppuration and excision. In my thesis I have shown, in fact, that after septic osteomyelitis in the metacarpal bones with sequestration and extrusion of the sequestrum, no lasting new bone formation is brought about by implantation of *os purum* after excision of the sear. *Os purum* melts away and is resorbed without leaving any newly formed bone behind.

In Case 3 an osteoplasty of a phalanx of a finger was done and the *os purum* was laid against the freshened defect on the surface of the bone.

CASE 1. V. N. aged 11 years history No. 6 83, 6949 and 7072. Diagnosis tuberculous osteitis of the left first metatarsal. On June 29 1931 a curet

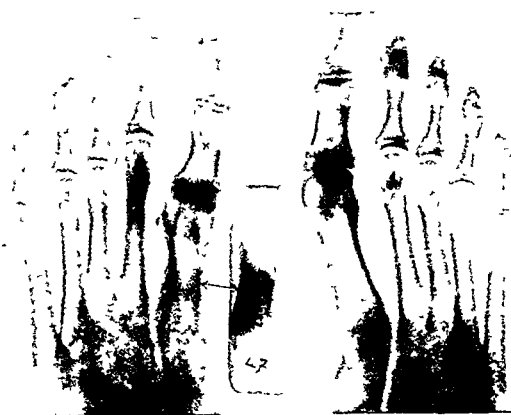


Fig 1 Case 1 Patient had tuberculous osteitis of the first metatarsal at age of 11 years X-ray photographs were taken when patient was 16 years old, 4 years and 8 months after resection and implantation of os purum The small insert shows the condition 48 days after operation The double arrow indicates the site of implantation

tage of the diseased area was done and a homoplastic bone implantation performed after resection of the bone The resected bone was replaced by os purum of similar shape There was primary healing, but about 4 weeks after operation slight swelling and a fistula appeared in the scar, from which clear fluid escaped The fistula dried up after a few days and healed rapidly The plaster cast was removed at the end of 11 weeks Five months after operation the patient was wearing shoes and walking about He was discharged 6 months after operation with a good functional and anatomical result, and went skiing without difficulty a month after coming home He was well at follow-up examinations in 1932, 1933, and 1936 (Fig 1)

CASE 2 H A V, aged 7 years, history No 6841 Diagnosis tuberculous osteitis of the right second metacarpal with sequestration of the metacarpal bone and abscess formation in the soft tissues On December 22, 1931, the bone was resected and a homoplastic bone implantation (os purum) was done The metacarpal was cut through proximally and distally and the interlying bone was removed The abscess in the soft parts was curetted out carefully and cauterized with phenol and alcohol As a substitute for the resected bone, a homoplastic graft of os purum was used After operation, the wound suppurated and broke down and on February 25, 1932, the implant was extracted and the wound cavity revised After the revision, the wound cleaned up quickly and epithelized over On March 16, 1932, implantations of fresh autoplasmic bone and homoplastic os purum were made The os purum (a proximal phalanx) was fitted into the volar half of the metacarpal region The dorsal half was replaced by a transplant taken from the tibia of the patient Healing by first intention occurred The plaster cast

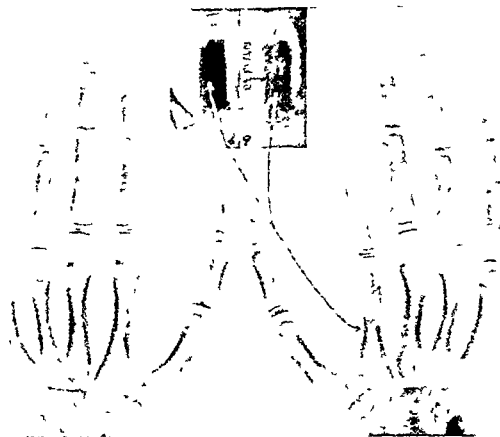


Fig 2 Case 2 Patient had tuberculous osteitis in the second right metacarpal at age of 7 years The x-ray pictures, showing the condition after resection followed by implantation of both os purum and fresh autoplasmic bone from the tibia, were taken when patient was 12 years old Inserts show the bone 69 days after operation

was removed 8 weeks after operation, and the patient was discharged on February 1, 1933 The index finger on the right hand was about 5 millimeters shorter than that on the left The metacarpophalangeal joint showed a range of 45 degrees of flexion and normal extension Follow-up examination in March, 1936, showed a good result with complete replacement of the implant by new bone (Fig. 2)

CASE 3 M H, aged 7 years, history No 6828 Diagnosis tuberculous osteitis of the left second metacarpal with deformity On August 11, 1931, homoplastic os purum (a middle phalanx) was im-



Fig 3 Case 3 Deformity of the middle phalanx of the index finger after healing of tuberculous dactylitis in boy of 7 years a and b, show finger during extension; c, 63 days, d, 610 days, and e, 1601 days after the implantation of os purum into the bone defect producing almost complete restoration of the shape of the finger, patient now 12 years of age.

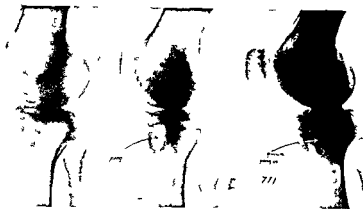


Fig 4 Case 6 Bone cyst in the right tibia for which curettage and implantation of os purum spongiosum was done Figure shows lateral x rays of the knee left before operation center 169 days after operation and right 711 days after operation Patient 27 years old

planted into the defect in the bone. The wound healed by first intention. The extension wire and plaster cast was removed at the end of 2 months and active motion of the interphalangeal joints begun. The result was good both from a functional standpoint and by x ray, with almost complete restoration of the distal interphalangeal joint and of the shape of the index finger. Follow up examination in March 1936 showed a good result with a complete rebuilding of the implant by new bone (Fig 3).

The rebuilding of os purum may thus be seen to be dependent entirely upon the connective tissue which is present in the bed. If the os purum is implanted beneath the periosteum or next to living bone which contains connective tissue, it is rebuilt without difficulty. If only extraskeletal connective tissue is found in the area around the os purum, the latter is absorbed without being replaced by new bone.

In Case 4 the patient, a 47 year old woman had a tuberculous lesion which was curetted out of the calcaneus and filled with os purum spongiosum. The rebuilding of the implant progressed slowly and was not complete by x ray 720 days after operation, but judging by its clinical appearance, it should have been complete.

CASE 4 I R aged 47 years history No 6709 Diagnosis tuberculous osteitis of the left calcaneus with sequestrum. On August 11 1931 the lesion was curetted out under general anesthesia and os purum spongiosum was implanted. Healing by first intention occurred. On October 21 a superficial ne-

crosis was noted in the scar of the operation on the lateral side of the heel from which clear fluid exuded. Later in November-December, 1931 the wound healed completely. The patient died May 6 1933 of uremia. She was examined the day before death and the heel was then well healed and looked entirely normal.

The 3 following cases illustrate the filling out of defects in the cancellous bone contiguous to the knee joint with os purum spongiosum. Cases 5 and 6 were also reported in my thesis, and are described again here after recent follow up examinations. Case 7 is rather interesting in that the patient had a large abscess extending from the bone lesion into the muscles which was found at the time the implantation was done. The implant began to be rebuilt as soon as the fistula closed and the abscess began to be resorbed.

CASE 5 K V J aged 16 years history No 7050 Diagnosis osteitis fibrosa of the medial condyle of the right tibia. At admission the patient showed general muscular atrophy of the right leg. On the posterior surface of the lateral condyle of the tibia there was considerable tenderness and a somewhat doughy swelling. The motion in the knee joint was fairly good. On May 26 1933 curettage of the lesion was done and os purum spongiosum was implanted. The report of the pathological examination was made by Dr C O Forselius as follows: The microscopic picture may be said to be between that of a fibrosarcoma and a giant cell tumor in any event non malignant. On August 29 1933 he was discharged healed with good motion in the knee joint but with a slight lump on walking. On August 28 1935 he had no complaints and had good motion.

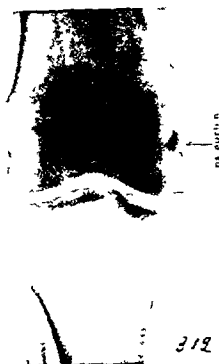


Fig 5 Case 7 Roentgenogram 10 months after curettage of tuberculous lesion and implantation of os purum, in patient 29 years old. The os purum has begun to be replaced by new bone.

CASE 6 H H R, aged 27 years, history No 7105, was admitted to hospital July 15, 1933, with a bone cyst in the medial condyle of the tibia. He had been previously treated in the United States of America. At admission the right knee was fixed in about 45 degrees of flexion and there was marked muscular atrophy of the leg. There was only slight swelling but pronounced tenderness over the medial condyle of the tibia. At operation on July 27, 1933, the tuberculous lesion was curetted out and os purum spongiosum was implanted. The lesion, of lima bean size, contained clear fluid, but no necrotic tissue. It was filled with os purum, and the healthy bone which had been removed was replaced in the bone canal also. Healing by first intention occurred. Seven weeks after operation the patient was allowed to get up without a dressing and was permitted active motion. He was discharged on October 21, 1933, with normal extension and 105 degrees of flexion. On November 12, 1934, he was in good general condition. He had no complaints referable to the knee, and had as good motion in the knee which had been operated on as in the other. There was no muscular atrophy. A certificate of good health was given for his return to the United States. The microscopic report by Dr C O Forselius read as follows: "Bone tissue, partly necrotic, partly forming new bone. The bone marrow is in large part fatty and poor in cells. Here and there a collection of lymphocytes and plasma cells but nowhere a picture typical of osteitis fibrosa" (Fig 4).

CASE 7 V F, aged 29 years, history No 7371. This patient had a tuberculous focus of hazel-nut size in the medial femoral condyle of the right femur with a large abscess in the soft parts. On April 30, 1935, the lesion was removed by operation and os purum spongiosum was implanted. Healing by first intention occurred. Repeated abscesses had to be drained subsequent to the operation. A fistula appeared again on August 17 and 5 to 10 cubic centimeters of thick pus was expressed through it. A progress note on November 24, 1935, stated that no suppuration



Fig. 6 Case 8 Top, 217 days after curettage of tuberculous lesion in the neck of the femur and implantation of os purum in boy of 7 years; center, 301 days later when a similar operation was performed on the acetabulum; bottom, 558 days after the first operation and 311 days after the second operation.

from the fistula had occurred for 14 days. The knee was then non-tender to palpation and there were no signs of abscess formation. The patient lacked 10 degrees of full extension, and the flexion ability lacked 30 degrees. She was out of bed the entire day without complaints. She was discharged on March 8, 1936, in good general condition. The knee was healed and had improved in its mobility. The muscles of the leg were stronger and there was beginning replacement of the os purum by x-ray (Fig 5).

Case 8 showed a tuberculous lesion in the neck of the femur which was curetted out and filled with os purum spongiosum. Half a year later a lesion was discovered in the acetabulum and was similarly treated. The wounds healed well after both operations. The joint space was normal and the function of the joint was good. In Case 9, a walnut-sized lesion in the os pubis was curetted out and filled with os purum with a similar result.

CASE 8. L B O, aged 7 years, history No. 7369. Diagnosis: tuberculous osteitis of the left femoral

neck and acetabulum. On September 18, 1934, the diseased area was removed surgically and os purum spongiosum implanted. In the anterior portion of the junction between the femoral neck and the trochanter granulation tissue was encountered, and a pea sized area of bone necrosis was curetted out and replaced by os purum. Healing by first intention occurred. On May 23, 1935, a diseased focus in the acetabulum was removed by a second operation and os purum spongiosum was implanted. A triangular flap of the outer table of the ilium was raised up with the base toward the edge of the acetabulum. The focus was reached with a curette, cauterized with carbolic alcohol and filled with os purum. First intention healing occurred. On May 3, 1936, the patient was in good general condition. The gait and motion in the hip joint was good (Fig. 6).

CASE 9. E. M. K. aged 4 years, history No. 7424. Diagnosis: tuberculous osteitis in the right os pubis with a walnut sized lesion in the superior ramus of the os pubis. At operation on April 4, 1935, the diseased area was removed and os purum spongiosum was implanted under ether anesthesia. The anterior wall of the symphyseal cartilage was intact. It was broken through carefully with a chisel where upon a cavity was encountered filled with necrotic and partially caseous masses. These were removed. The cavity had a very irregular shape but was filled up as well as possible with os purum. Healing by first intention occurred. On May 3, 1935, the patient was in good general condition. Rebuilding of the os purum had taken place to a considerable degree according to x rays but was not yet fully complete.

Cases 10, 11 and 12 exhibited tuberculous lesions with involvement of the neighboring joints in one or more tarsal bones. These lesions were curetted out and filled with os purum. In all these cases, healing was by first intention and the subsequent function was good. Of these cases, Case 10 has been followed 483 days and the rebuilding has been good. Case 12 has been followed 1½ years.

CASE 10. W. G. S. aged 24 years, history No. 7236. Diagnosis: tuberculosis of the right tarsus. Neither tenderness nor swelling over the talocalcaneal joint was very great although the patient complained of pains in the heel upon walking. There was some limitation of dorsal flexion of the foot. The right calf measured 3 centimeters less in circumference than the left. At operation on May 12, 1934, the lesion was found lying immediately against the talocalcaneal joint and was curetted out and replaced with os purum spongiosum under spinal anesthesia. The pathological report was tuberculosis. The wound healed by first intention and the patient was discharged on July 5, 1934, free of complaints. On September 7, 1935, he still was without complaints and had good motion in the foot.

CASE 11. J. P. J. aged 64 years, history No. 7355. On the medial border of the right foot there was an ulcer about 1 centimeter long at the anterior border of the os naviculare with low grade suppuration. There was no swelling of the soft parts. There was tenderness to palpation on the dorsum of the foot over the os naviculare. At operation on November 17, 1934, under local anesthesia, a small cavity containing granulations was encountered which extended forward toward the joint between the os naviculare and the first os cuneiforme. The lesion together with the neighboring bone and portions of the cartilage were curetted out and replaced with os purum. The wound healed by first intention and the patient was discharged on February 21, 1935, with a good anatomical and functional result.

CASE 12. A. E. N. aged 25 years, history No. 7191. Diagnosis: tuberculosis of the tarsus with multiple osteitis. For about 2 months there had been tenderness upon palpation of the dorsum of the right foot especially immediately anterior to the head of the talus. By x ray osteoporosis of the metatarsal bones was apparent and the joint cartilage of the small joints of the right foot did not show as clearly as those of the left foot. Curettage of the bone lesion was performed on November 30, 1930, under spinal anesthesia. The joint capsule between the os cuboideum and the third os cuneiforme showed pathological changes and was excised. In two neighboring portions of the bone tissue showing tuberculous changes was curetted away. The portions curetted out were replaced by os purum spongiosum. The wound healed by first intention. At follow up examination on May 3, 1936, the result was good both functionally and by x ray.

In Cases 13 to 17, tuberculous lesions of the bone at the wrist, with involvement of the neighboring joints, were curetted out. In 3 of the cases (13, 15, and 17) the healing and rebuilding has been exceptionally good. Two of the cases which had large abscesses and fistulas before operation had postoperative complications. Case 14, a flaring up of pulmonary tuberculosis (patient referred to a sanatorium). Case 16, an old woman, a pulmonary embolus 5 months after operation causing sudden death.

CASE 13. E. E. aged 24 years, history No. 7101. Diagnosis: tuberculous arthritis of the right radio carpal joint with abscess formation and threatening perforation of the skin. At operation on August 1, 1933, the bone lesions in the os naviculare, os lunatum and radius were curetted out under brachial plexus block anesthesia and os purum was implanted. The wound healed by first intention. However, in the third week after operation a few drops of clear fluid appeared through a small fistula in the scar but subsequently remained dry. Three months

TABLE I—IMPLANTATION OF OS PURUM IN RESECTIONS OF THE ANKLE JOINT FOR TUBERCULOSIS

Case No	History No	Patient's initials	Age	Sex	Resection		Healing	Walked without cast most postoperative	Rebuilding of implant—days after operation	Form of foot	Remarks
					Date	Anesthesia					
18	6633	E I K	17	♂	9-9-31	E	Primary	3	Good, 330	Good	15-20° motion
19	6573	K. M A	9	♀	9-19-31	E	Primary	2 1/2	Good, 328	Good	Ankylosis
20	6838	B E	20	♂	4-6-32	E	Primary	2	Good, 388	Good	5° motion
21	6877	S C S	16	♀	10-6-32	S	Primary	4	Good, 650	Good	Ankylosis
22	7005	T I P	25	♀	5-11-33	E	Primary	4	Good, 390	Varus	Ankylosis
23	7151	I L	13	♀	11-30-33	E	Primary	3	Good, 422	Good	Ankylosis
24	7280	A E F	49	♀	1-17-35	S	Fistula		0	Good	Ankylosis
25	7359	B G C	18	♂	1-26-35	S	Primary	3	Good	Good	Ankylosis

E=Ether anesthesia, S=Spinal anesthesia

after operation the plaster cast was dispensed with and free use was permitted. The functional and anatomical result was good and there was no collapse of the os purum. A fair amount of motion returned in the wrist joint. Patient has been re-examined every 6 months.

CASE 14. E I E A, aged 30 years, history No 7047. Diagnosis: tuberculosis of the wrist joint with abscess formation and threatening perforation of the skin. A resection of the wrist joint was performed on August 1, 1933, under ether anesthesia. The resected bone was replaced by a layer of os purum spongiosum. Healing was complicated by the appearance of a fistula which soon dried up. The patient was referred to a sanatorium for pulmonary tuberculosis 6 months after operation, where she died a few months later.

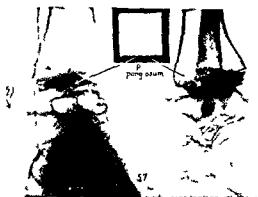
CASE 15. B A O., aged 26 years, history No 7366. Diagnosis: tuberculosis of the left wrist joint with multiple areas of osteitis. There had been increasing diffuse swelling of the left wrist with the formation of a fluctuant abscess on the dorsal aspect. Curettage of the bone lesion and implantation of os purum spongiosum was done on October 10, 1934. The joint capsules were excised and replaced with os purum. Healing appeared to be by first intention, but about 2 months after operation there was some serous discharge through a small fistula in the scar. A small abscess appeared in the skin and was incised. After this procedure was carried out prompt healing followed.

CASE 16. Age 68 years. History No 7399. Diagnosis: tuberculosis of the wrist with abscess formation and threatening perforation. Perforation occurred on December 29, 1934. At operation on January 3, 1935, a large tuberculous lesion was curetted out of the wrist bones and the radius and was replaced by os purum spongiosum, under brachial plexus block anesthesia. Healing was complicated by suppuration through a fistula. The patient died suddenly of a pulmonary embolus on May 7, 1935. No postoperative x-ray pictures had been taken before death occurred.

CASE 17. A E P, aged 29 years, history No 7421. Diagnosis: tuberculosis of the right wrist. There was marked swelling and destruction of the end of the radius and the proximal carpal bones at admission. Curettage of the lesion was done on June 7, 1935, and the removed bone was replaced by implantation of os purum spongiosum under brachial plexus anesthesia. The wound healed by first intention. The plaster cast was dispensed with after about 2 months. The patient was discharged on September 13, with the wound well healed. The hand was in good position and had good contour, without collapse of the area. There was only a couple degrees of motion in the wrist joint, but there was good motion in the finger joints. At follow-up examination on February 3, 1936, the mobility and strength had increased. The result was good, both from a functional standpoint and by x-ray.

Table I gives data regarding 8 cases (Cases 18 to 25) of tuberculosis of the ankle joint in which resection was performed and the resected bone was replaced by a piece of os purum spongiosum with the aim to preserve the shape of the foot as much as possible. In all except Case 24, in which a fistula was present before operation, healing was by first intention. The strength and rebuilding of the implants, and also the shape of the foot, have all been good.

CASE 18. E I K., aged 17 years, history No 6633, 6956, 7073, 7363, and 7586. The patient had an old tuberculosis of the right talocrural joint which had flared up several times. A trial of conservative treatment was first made, but swelling, tenderness on pressure, and pains about the joint persisted. On September 9, 1931, a resection of the ankle joint was done and the resected bone was replaced by implantation of homoplastic os purum spongiosum. The wound healed by first intention, and the pa-



Figs 7 and 8 Case 18 Figure 7 was taken 57 days after resection of the ankle joint and insertion of os purum for



tuberculosis in a patient 17 years of age Figure 8 was taken 4 years after operation

tient was out of bed walking in a cast 3 months after operation. There was functional and anatomical healing without collapse of the os purum (Figs 7 and 8). Follow up examination in August, 1935 showed the foot to be in good position with 5 to 10 degrees of equinus. The range of motion for plantar and dorsal flexion was 15 to 20 degrees. A few degrees of pronation and supination were present. There was no pain on motion and general strength was satisfactory. The calf musculature of the right leg was somewhat atrophied. He could walk remarkably well and could run easily and without difficulty. The patient worked in a lumber yard carrying planks and lumber without trouble.

CASE 19 K. M. A. aged 9 years history No 6573 69.55 The patient was admitted to the hospital with signs of an acute process in an area of old tuberculosis in the right talocrural joint. The patient was treated conservatively at first but because of angu-

lation of the foot resection of the joint was decided upon. This was performed on September 9 1931 and the resected bone was replaced with a piece of os purum spongiosum. The wound healed by first intention and the patient was up and walking with a plaster cast 2½ months after operation. The functional and anatomical result was good without collapse of the os purum. The patient was discharged on April 22 1932. Follow up examination on August 10 1932 showed the foot to be well healed and ankylosed in good position.

CASE 20 B. F. aged 20 years history No 6838 Since the end of 1920 the patient had had symptoms from tuberculosis of the talocrural joint sometimes improving then becoming worse again. There had been abscess formation of late. On April 6 1932 resection of the joint was performed and the resected bone was replaced with a layer of os purum spongiosum. On June 9 the patient was out of bed walking with a plaster cast and was discharged on September 30 with a leather support which he wore until January 15 1933. He then walked well without it. Three years after operation on July 14 1935 his general condition was good. The sedimentation rate was 4 millimeters in an hour. The position of the foot was good and there was no difficulty in walking even when the gait was rapid. There was about 5 degrees of motion in the ankle joint. There was no impairment of motion in the toes or knee and he had no pain or tenderness. He has now learned the tailoring trade having been a textile worker prior to his illness.

CASE 21 S. C. S. aged 16 years History No 6877 The patient entered with an exacerbation of old tuberculosis of the left talocrural joint. Since her fistulas had closed on September 1 1932 a resection of the joint was done October 6 1932 and the resected bone was replaced with os purum spongiosum. First intention healing was obtained. The patient walked without her plaster cast in the fourth month after operation. There was good functional and anatomical healing without collapse of the os purum. She was discharged on March 19 1933 with

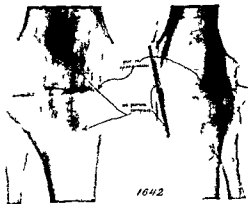


Fig 9 Case 26 Tuberculosis of the knee joint in patient aged 37 years. Anteroposterior and lateral roentgenograms 4½ years after resection of the joint and implantation of os purum spongiosum together with a tongue of os purum compactum.

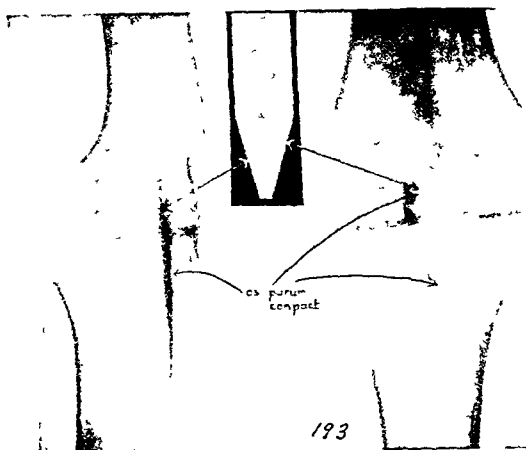


Fig 10 Case 39 Tuberculosis of knee joint in a patient 21 years old Anteroposterior and lateral views 193 days after resection of the joint and implantation of a tongue of os purum compactum

the wound well healed and with good motion in the joints of the foot. The cast was dispensed with on March 10, 1935. Follow-up examination 2½ years after operation showed good general condition. The patient walked well without a limp, but she experienced occasional ache in the joints of the foot with change in weather. She works at home.

CASE 22 T I P, aged 25 years, history No 7005. Diagnosis tuberculosis of the left talocrural joint. The patient had had trouble with the left foot since the beginning of 1932. An operation was decided upon, since the trouble did not disappear in spite of bed care and fixation in plaster. A resection of the joint was done on May 11, 1933, and the resected bone was replaced with os purum spongiosum. Healing was by first intention. The plaster cast was removed 2 months after operation, and 4 months after operation the patient was able to walk without a supporting bandage. There was good functional and anatomical healing without collapse of the os purum, but there was some valgus position of the foot because the os purum had not been correctly shaped. At follow-up examination on June 12, 1934, the general condition was good. The valgus position was still present. There was 10 degrees of motion in the ankle joint. She had worked at home house-keeping for the last 7 months without trouble.

CASE 23 I L, aged 13 years, history No 7151. The patient was admitted to the hospital August 28, 1933, with a diagnosis of tuberculosis of the left talocrural joint. For 4 weeks a latent tuberculosis of this joint had been flaring up. Operation was decided upon because of threatening perforation of secondary abscesses. A resection of the joint was performed on November 30, 1933, and os purum was inserted to replace the resected bone. Healing was by first intention and the patient was out of bed walking without a cast on March 1, 1934. He was



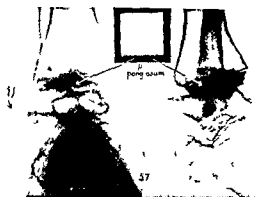
Fig 11 Case 37 Tuberculosis of the knee joint with atrophic and friable cancellous bone in patient 27 years old. Roentgenogram shows condition 111 days after resection of the joint and implantation of a thick plate of os purum spongiosum.

discharged on May 14, 1934, with some atrophy of the musculature of the left thigh and calf. He had then been up and about for a month and could walk well. The foot had good shape and good function. On August 17, 1935, the general condition was good, and the gait was satisfactory. The foot looked well, still had good shape, and did not swell. The sedimentation rate was 25 millimeters. The patient was taking part in all kinds of sport.

CASE 24 A E F, aged 49 years, history No. 7280. Diagnosis tuberculosis of the right talocrural joint with fistula formation. The patient had had aches



Fig 12 Case 47 Tuberculosis of the shoulder joint in a woman 52 years of age. Roentgenogram shows the condition 328 days after shoulder joint resection with implantation of os purum in a large defect in the cancellous portion of the head of the humerus.



Figs 7 and 8 Case 18 Figure 7 was taken 57 days after resection of the ankle joint and insertion of os purum for



tuberculosis in a patient 17 years of age Figure 8 was taken 4 years after operation

tient was out of bed walking in a cast 3 months after operation. There was functional and anatomical healing without collapse of the os purum (Figs 7 and 8). Follow up examination in August, 1935 showed the foot to be in good position with 5 to 10 degrees of equinus. The range of motion for plantar and dorsal flexion was 15 to 20 degrees. A few degrees of pronation and supination were present. There was no pain on motion and general strength was satisfactory. The calf musculature of the right leg was somewhat atrophied. He could walk remarkably well and could run easily and without difficulty. The patient worked in a lumber yard carrying planks and lumber without trouble.

CASE 19 K M A aged 9 years history No 6573 6955. The patient was admitted to the hospital with signs of an acute process in an area of old tuberculosis in the right talocrural joint. The patient was treated conservatively at first but because of angu-

lation of the foot, resection of the joint was decided upon. This was performed on September 9 1931 and the resected bone was replaced with a piece of os purum spongiosum. The wound healed by first intention and the patient was up and walking with a plaster cast 2 1/2 months after operation. The functional and anatomical result was good without collapse of the os purum. The patient was discharged on April 2, 1932. Follow up examination on August 10 1932 showed the foot to be well healed and ankylosed in good position.

CASE 20 B E aged 20 years, history No 6838. Since the end of 1929 the patient had had symptoms from tuberculosis of the talocrural joint sometimes improving then becoming worse again. There had been abscess formation of late. On April 6 1932 resection of the joint was performed and the resected bone was replaced with a layer of os purum spongiosum. On June 9 the patient was out of bed walking with a plaster cast and was discharged on September 30 with a leather support which he wore until January 15 1933. He then walked well without it. Three years after operation on July 14 1935 his general condition was good. The sedimentation rate was 4 millimeters in an hour. The position of the foot was good and there was no difficulty in walking even when the gait was rapid. There was about 5 degrees of motion in the ankle joint. There was no impairment of motion in the toes or knee and he had no pain or tenderness. He has now learned the tailoring trade having been a textile worker prior to his illness.

CASE 21 S C S aged 16 years History No 6877. The patient entered with an exacerbation of old tuberculosis of the left talocrural joint. Since her fistulas had closed on September 1 1932 a resection of the joint was done October 6 1932 and the resected bone was replaced with os purum spongiosum. First intention healing was obtained. The patient walked without her plaster cast in the fourth month after operation. There was good functional and anatomical healing without collapse of the os purum. She was discharged on March 19 1933 with

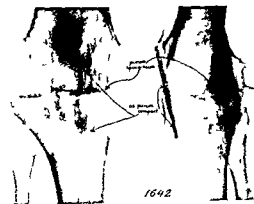


Fig 9 Case 26 Tuberculosis of the knee joint in patient aged 37 years. Anteroposterior and lateral roentgenograms 4 years after resection of the joint and implantation of os purum spongiosum together with a tongue of os purum compactum.

TABLE II.—IMPLANTATION OF OS PURUM IN RESECTIONS OF THE KNEE JOINT FOR TUBERCULOSIS

Case No	History No	Patient's initials	Age	Sex	Osteosynthesis		Healing	Cast removed— mos after operation	Rebuilding of implant and result
					Date	Anesthesia			
26	6840	A B A.	37	♂	12-22-31	E	Primary	6	Good
27	6879	A L O	28	♀	5-21-32	E	Primary	4	Good
28	7044	F A	22	♀	5-9-33	E	Fistulas	11	Good
29	6993	J A P.	23	♂	6-8-33	S	Primary	Followed at another clinic	
30	7116	J G W.	16	♂	8-24-33	S	Primary	Not recorded	
31	7033	A M J	50	♀	10-26-33	S	Primary	7	Good
32	7293	E V E	24	♀	6-26-34	S	Primary	7	Good
33	7182	F S	31	♂	7-17-34	E	Primary	7	Good
34	7346	E B	20	♀	7-24-34	S	Primary	6	Good
35	7317	O F K.	45	♂	8-7-34	E	Died 8-8*		
36	6935	S W.	16	♂	10-9-34	E	Primary	Not recorded	
37	7231	B J	27	♀	10-16-34	S	Primary	Referred to sanatorium for pulmonary tuberculosis	Good†
38	7296	T G Y	23	♂	1-18-35	S	Primary	Referred to sanatorium for pulmonary tuberculosis	Good†
39	7416	H M L	21	♀	9-27-35	S	Primary	6½	Good
40	7605	S O K	24	♂	10-12-35	S	Primary		Good
41	7366	B. A. O	27	♂	10-18-35	S E	Primary		Good
42	7630	K. I D	25	♀	1-18-36	S	Primary		Good
43	7652	K. A. H	18	♂	1-30-36	S	Primary		Good

E=Ether, S=Spinal anesthesia

*Heart failure

†Refers to result only

with such an osteosynthesis, and the plaster cast may be taken off as early as 6 months after operation. The expense of a leather support is eliminated by these measures

Judging from the x-ray pictures, it takes about 1 year before the bony structures in the tibia and femur begin to grow over into one another. In the anteroposterior views, the tongue of bone is well outlined until about 400 days after operation; subsequently it is difficult to make out. In the lateral views, however, the tongue of bone may be seen to be more dense than the surrounding bone as late as 4 years after operation. Compact os purum is rebuilt very slowly (see Figs 9, 10, and 11).

In Table III, 5 cases of shoulder joint tuberculosis which have been treated by resection are described (Cases 44 to 58). At operation, the defects in the resected ends have been replaced with os purum spongiosum and the end of the humerus held in position by means of a

tongue of bone driven into the anterior margin of the glenoid labrum. Healing has invariably been by first intention and union has been good. The rebuilding of the implant has also been good. In these cases evipan and ether anesthesia have been used in combination, with great advantage. Since the cases have not been followed more than 1 year, the rebuilding of the implants is not yet complete.

CASE 44. E G K, female, aged 18 years, history No 7289. Diagnosis: tuberculosis of the right shoulder joint. The patient had had pain, tenderness, and increasing stiffness in the right shoulder joint, since 1931. On March 29, 1933, a resection of the shoulder joint was done under ether anesthesia. The head contained extensive necrotic areas which were cleaned out. The posterior portion of the capsule of the shoulder joint contained a great deal of granulation tissue and caseous material. A secondary abscess had formed in the axilla. All the diseased tissue was removed. The cartilage of the glenoid cavity was necrotic with caseous areas beneath. These were curetted out also. When the head of the humerus and the glenoid cavity were smoothed off, they did



Fig 13

Fig 13 Case 49 Genu varum following tuberculous coxitis in a girl of 13 years. Roentgenograms show condition left the day following an infracondylar osteotomy on the tibia and interposition of os purum compactum to maintain good position center 202 days after operation and right 455 days after operation.

Fig 14 Tampons of pear wood with which the os purum spongiosum is packed into the site of implantation.



Fig 14

and swelling in the right foot since the beginning of 1934. At admission on May 15 1934 there was on the right foot just lateral to the malleolus a fistula about 1 centimeter in diameter and with considerable discharge. The fistula had soft granulations in its depths and the skin immediately surrounding it was bluish red in color. The underlying tissues were somewhat swollen. Motion of the ankle joint was especially painful upon flexion. On January 15 1935 there was only a slight amount of secretion from the two fistulas. A resection of the ankle joint was performed on January 17 1935. Many masses of tuberculous granulations were found in the capsule and on the surface of the joint. The joint cartilage was missing. The granulations were removed and the surface of the joints was scraped clean and smoothed off, after which a layer of os purum spongiosum about 1 centimeter thick was placed between the surfaces of the resected area. On July 13 the patient was permitted to walk with a plaster cast and on December 27 it was dispensed with. At follow up examination on January 29 1936 it was learned that there had at times been some serious discharge through a small fistula since operation. X-ray examination revealed that the implant had maintained itself well but had not yet begun to be rebuilt.

CASE 25 B C F C aged 17 years history No 7359 7394. Diagnosis tuberculosis of the left talocrural joint. The patient was admitted to the hospital on August 17 1934. There had been swelling of the foot since March 1934. A resection of the

joint was done on January 26 1935. The resected bone was replaced with a layer of os purum spongiosum and healing by first intention was obtained. The plaster cast was removed April 8. The patient walked without support on April 24 and was discharged June 6 1935 without complaints and with a well healed wound.

In Table II 18 cases (Cases No 76 to 43) of knee joint tuberculosis treated by resection are outlined. I have not included the full case histories for lack of space. The implantation of os purum in these cases is only one step in a resection which is often quite complicated and meticulous in its performance.

At resection the defects in the resected surfaces were replaced with os purum spongiosum and the resected ends were united by osteosynthesis by driving in a strong tongue of os purum compactum through the anterior portions of the tibia and femur in the frontal plane. The latter procedure is an advantageous technical detail in the operation. After the tongue of bone has been driven in, it is considerably easier to put on the plaster cast with the leg in good position than if only sutures are used. More important however is the fact that bony union becomes firm earlier.

TABLE III—IMPLANTATION OF OS PURUM IN SHOULDER JOINT RESECTIONS FOR TUBERCULOSIS

Case No	History No	Patient's initials	Sex	Age	Resection			Healing	Remarks	Rebuilding of implant	Ankylosis
					Date	Anesthesia	Type of operation				
44	7289	E G K	♀	19	3-29-33	E	B	Primary	Cast removed 5-28-34	Good	Yes
45	7395	O K	♂	33	2-2-35	E	B	Primary	Leather support—removed 4-6-36	Good	Yes
46	7435	T A	♂	30	4-5-35	Ev-E	D	Primary	Leather support—	Good	Yes
47	7392	A P.	♀	52	3-4-35	Ev-E	D	Primary	Leather support—	Good, not complete	Yes
48	7425	T B	♂	46	3-13-35	Ev-E	B-D	Primary	Leather support—removed 3-25-36	Good, not complete	Yes

E=Ether, Ev-E=Evipan-Ether, B=Tongue of os purum; D=Defect in bone substance replaced by os purum

CASE 49 E B, aged 13 years, history No 6846
Diagnosis genu varum following tuberculous coxitis. On March 18, 1933 an infracondylar osteotomy of the tibia was done and os purum was implanted. After the usual incision in the soft parts, the operation was carried out with drill and osteotome. With retractors the ends of the bone were forced apart, and small pieces of os purum were interposed between the medial ends of the bones so that the proper relationship between them existed. The periosteum and the overlying soft parts were sutured. A fenestrated circular plaster cast was placed about the leg and foot. Healing was by first intention. At the end of 8 weeks, the patient was up and walking with the plaster cast on. Figure 13 shows the x-ray pictures the day after operation, 202 days after operation, and 455 days after operation. The patient was discharged on January 17, 1934, with complete ankylosis in the left hip joint and with the lower leg in good position. She limped slightly but otherwise walked quite well.

Implantation of os purum has given healing by first intention as a general rule. During the third or even the seventh week after implantation, a fistula has sometimes appeared in the scar and serous fluid broken out through it, probably due to tissue necrosis. The discharge has usually ceased after 1 or 2 weeks, and the wound has subsequently remained dry. The portion of the body operated upon has in general been immobilized in a plaster cast for 2 or 3 months after the implantation, and the cast has been fenestrated over the wound so that the latter could be observed carefully. The wound has been covered with a bandage only during the first few days after operation and afterward left exposed to the beneficial effects of sunlight and ventilation.

According to the results of my own investigations, implantation of os purum should be

preferably done in cases of bone tuberculosis when the disease is in a quiescent stage and when the lesions have shown some tendency toward localization. Even in many cases of joint resection in more active forms of tuberculosis, however, os purum may give a good result. It is only in cases in which fistulas have formed, or in cases in which the overlying skin has been rendered thin and unhealthy by secondary infection or abscess formation that the implant is sometimes extruded. Considerable space would be required to review in detail the indications for operation, at least so far as surgical tuberculosis is concerned. These can be learned only through practical experience in the clinic where one may see for himself and follow the treatment and course of healing among the cases.

When one wishes to learn the technique of the use of os purum for implantations, he should begin with simple procedures. Later, after a survey of the results of these cases, he should pass on to more difficult problems. In this way uncertainty is eliminated and increasing trust in the use of os purum is acquired.

In using os purum, an especially careful aseptic technique is demanded, together with a few specially constructed simple instruments which have been described in previous communications.^{1,2} Besides these instruments, it is advantageous to have wooden tampons (Fig. 14) for the introduction of the os purum into its bed. Sterilization of os purum is most easily accomplished by boiling in physiological

¹Orell, Svante. Osteoplastic cuneiform osteotomy in the treatment of ankylosis. *J. Bone & Joint Surg.*, 1932, 14, 613.

²Idem. Interposition of os purum in osteosynthesis after osteotomy, resection of bones and joints (Interposition-osteosynthesis). *Surg., Gynec. & Obst.*, 1934, 59, 638.

not fit each other well the head tended to luxate anteriorly. A tongue of os purum was therefore driven into the anterior portion of the glenoid rim in order to hold the head in place. Good position then seemed to be maintained. On April 29 1936 the general condition was good. The patient stated that she occasionally had pain in the region of the scapula, probably originating in the musculature. The shoulder joint was ankylosed with the upper arm held at an angle of 60 to 70 degrees with the lateral edge of the scapula.

CASE 45 O K male, 31 years of age, history No 7395. Diagnosis tuberculosis of the left shoulder joint. The patient had been well until the autumn of 1933, when he first noticed a swelling in the left supraclavicular fossa. This swelling produced no subjective discomfort, but increased gradually in size. In May 1934 it was of hen's egg size. On February 12, 1935 the shoulder joint was resected under ether anesthesia. The head of the humerus contained a sequestrum the size of a walnut, which was removed. The joint capsule was also removed. The glenoid cavity was cleaned out with a curette, and a tongue of os purum was driven into the anterior edge against which the smoothed off head of the humerus rested so that it was held in good position. A fenestrated circular plaster bandage was placed about the thorax upper arm and forearm. The wound healed by first intention and the patient was discharged May 25 1935, wearing the plaster cast. He has returned for observation every 3 months. On April 6 1936 the general condition was good and the plaster was removed. There was ankylosis of the shoulder joint. Remnants of the tongue of bone were still visible in the x ray pictures.

CASE 46 T A male aged 29 years history No 7435. Diagnosis tuberculosis of the right shoulder joint. Since July 1934 the patient had had continual trouble with increasing stiffness in the right shoulder joint. On April 5, 1935, the shoulder joint was resected under evipan ether anesthesia. The cartilage on the humeral head was necrotic and was loosened over its greater part. Several pea sized tuberculous areas in the head were curetted out and cleared of granulations. The entire capsule was carefully removed. The glenoid cavity was curetted free of necrotic cartilage granulations and caseous material. In the lower portion of the glenoid cavity a funnel shaped cavity was encountered having a base about 1 centimeter in diameter. This was also curetted out. The entire field of operation was cauterized with carbolic acid and alcohol and the defect in the glenoid cavity was filled with os purum spongiosum. The head was easily fitted into the glenoid cavity and fixed in 90 degrees of abduction 20 degrees of forward flexion and 20 degrees of internal rotation. A fenestrated circular plaster was made to include the thorax the upper arm and forearm. Healing was by first intention and the patient was discharged on June 5 wearing the plaster cast. He returned every 3 months for observation. On February 5 1936 the shoulder joint looked fine and

had good stability. The scar was well healed. There was good motion in the elbow and hand and the strength was good. X ray picture showed that healing and consolidation were taking place.

CASE 47 A P, aged 52 years history No 739. Diagnosis tuberculosis of the right shoulder joint. The patient had had ache soreness, and stiffness in the right shoulder joint since 1930 and had recently had a secondary abscess. The joint was resected on March 4 1935. In the center of the head of the humerus, a large caseous necrosis was found. This was curetted out and filled with os purum spongiosum. Healing occurred by first intention and the patient was discharged on August 24, 1935 with the arm in a leather support. On January 26 1936, the joint was well healed with the arm in good position. The joint has since become ankylosed (Fig. 12).

CASE 48 T B male aged 45 years history No 7425. Diagnosis tuberculosis of the right shoulder joint. The patient had had trouble with the right shoulder joint since childhood. During the last 2 years he had had increasing aches and pains in it together with diminution in the mobility of the joint. The patient consented to operation and on March 13 1935 a shoulder joint resection was done under evipan ether anesthesia. The head was found to be luxated and was replaced. The joint capsule was excised and the wound cavity cauterized with carbolic acid and alcohol. Because of the marked adduction contracture the head was smoothed off, whereupon lesions were found within it. One bean sized area extended down into the neck of the humerus. These were curetted out and filled with os purum spongiosum. In order to hold the head in the glenoid cavity, a tongue of os purum was driven into the antero-superior portion of the glenoid rim. A fenestrated circular plaster cast was made to include the thorax upper arm and forearm. Healing was by first intention and the patient was discharged on May 24 with a shoulder cast. On April 10 1936 the general condition was good. There was bony union by x ray examination. The patient had removed the cast 14 days previously. He was engaged in slow work and played the piano and violin without difficulty.

Case 49 is one of interposition osteosynthesis of the tibia for genu varum following tuberculous coxitis. In the same manner that a bone fragment can prevent reposition in a comminuted fracture and fix the ends of the bone in a faulty position, so through the use of interposition in an osteotomy, bone or joint resection, fracture, etc. reposition and fixation of the ends of the bone in the desired position may be obtained. This is especially important in osteotomies etc. in which fixation after reposition often cannot be done at all or with great difficulty solely by means of external appliances.

DIABETES AND PREGNANCY

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IT IS now more than a decade since the use of insulin in the diabetes of pregnancy became general. A sufficient time has therefore elapsed for the collection of material upon which to base reliable estimates of its effectiveness. Among the many contributions to the subject in the literature, the most notable are those of Skipper, White, and Peckham. A body of opinion has been built up by these and other studies which may be given a brief review.

The disease may antedate or arise in pregnancy; it may be either mild or severe, and either badly or well controlled by treatment. Unquestionably, severe diabetes affects the reproductive function adversely. Menstrual irregularities or amenorrhea are almost the rule in severe diabetes, as are undernourishment and retarded development. The effect of this in reducing activity of the pituitary, thyroid, and reproductive glands is well known. A lack of estrin, a disappearance of graafian follicles and lack of genital development are described. It is the common experience that these deficiencies may be overcome by proper insulin treatment, and one result of such treatment is the greater fecundity of the victim of severe diabetes, a fact which complicates the problem of management during gestation and labor.

Diabetes with onset during pregnancy presents diagnostic problems for a number of reasons. The metabolic equilibrium of pregnancy is relatively unstable. In addition to the disordered carbohydrate metabolism there is an increased metabolic rate averaging 14 per cent in the last trimester, a diminished alkali reserve, a tendency to acidosis, a lowered plasma combining power of the blood for carbon dioxide, and a tendency to depletion of the glycogen store with resulting hypoglycemia. A lowered renal threshold for glucose is common in pregnancy, often associated

with a lowered assimilation limit for carbohydrate. Even in the non-diabetic pregnant woman the blood sugar curve after the administration of 100 grams of glucose may approach or assume the "plateau" or diabetic form. In most cases these metabolic changes are temporary; in a few they mark the onset of diabetes. Often only after careful and repeated study of the sugar in the blood and urine is it possible to determine whether or not a given pregnant patient with glycosuria is really diabetic, and on occasion a follow-up study in the postpartum period may be necessary.

The requirements of the fetus create a demand for about 50 grams of additional carbohydrate each 24 hours in the later months of pregnancy. The possibility that the fetal pancreas and other glands of internal secretion supplement corresponding maternal mechanisms is not yet definitely proved. This may well introduce a further factor making for a disturbed physiological equilibrium.

As regards the infant, diabetes in pregnancy is almost if not quite as menacing as in the pre-insulin era. The fetal and infant mortality remains little changed and seems to vary directly with the severity of the maternal diabetes and the effectiveness of its control. An opinion widely expressed states that the children of diabetic mothers weigh at birth much more than the average. This has been said to lead to prolonged labors with attendant possibility of fetal or maternal injury. The explanation for this increase of fetal size is not clear, and the anomaly is said not to have varied since the administration of insulin. Theoretical speculations assign it to super-alimentation, the consequence of maternal hyperglycemia or lipemia, to hyperplasia of the fetal islands of Langerhans, or to anomalous endocrine influences. That the increase is due largely to skeletal development and to fat brings up the question of the possible implication of the pituitary. The recent findings of Smith of a prolactin-estrogen imbalance in

sodium chloride solution, this, in addition, slightly softens the collagen in the os purum and perhaps makes it more easily soluble by the cells and tissue juices in the tissue bed. Since the os purum becomes somewhat soft in consistency after sterilization, wooden instruments spare the soft spongy framework more than hard steel instruments.

It must be remembered, in the use of os purum, that a good clinical result from its implantation may be expected only when skeletal connective tissue is present in the bed of implantation. Thus, in implants into the epiphysis large surfaces of cancellous bone must lie against the os purum, and in implants into the diaphysis, living periosteum as well as compact bone must surround it.

SUMMARY

In bone implantations, either fresh bone which contains connective tissue may be used, or a specially prepared bone introduced by the author and called "os purum," or the two may be used together. Cooked bone which has been dried, or bone which has been fixed in fixing solutions is not suitable for implantations. The use of os purum has the following advantages:

1. Since fresh autoplasmic bone contains living bone connective tissue, it must be treated with great respect at implantation. Os purum, however, can be handled with much greater freedom and may be shaped in any

manner best adapted to the situation provided it is sterile when placed in the tissues.

2. Os purum may be stored and kept over a considerable period of time, and a number of sizes and shapes may be prepared by machine beforehand. The form best suited for the portion of the skeleton which is to be repaired or reshaped may then be selected from among them.

3. No limitations as to size and shape are imposed, as is true when fresh bone is taken from the patient's own skeleton.

4. By using os purum in bone implantations, the accessory operation to obtain fresh autoplasmic material is rendered unnecessary. The operative procedure is thereby shortened and simplified, and the risk for the patient is consequently lessened.

5. By implantation of os purum together with fresh autoplasmic material, the more difficultly obtained material may be spared and good shape and filling still be attained in the injured or deformed skeletal part by the supplementary use of os purum.

A series of cases of tuberculous osteitis and osteoarthritis is reported, together with a case each of bone cyst and osteitis fibrosa, in the operative treatment of which, os purum has been implanted in various ways. In the cases os purum has healed in, as a rule, without complication and has had sufficient stability for its mechanical task until it has been gradually rebuilt and replaced by new bone.

TABLE III.—PREVIOUS OBSTETRICAL HISTORY

Patient No	Gravidity	Pregnancies	Dead
7	11	First 6 fullterm living at birth, 1 postnatal death, 1 stillbirth, 3 miscarriages	5
8	2	Abortion, 3 months, fullterm stillbirth, 10 lbs	2
5	4	First 3 babies, fate unknown, 1 fullterm died at 4 mos, 1 stillbirth	1
11	6	All weighed 10 to 12 lbs, 2 postnatal deaths, 1 stillbirth	3
13	8	2 stillbirths, 2 spontaneous abortions	4
16	4	Hard labors, all weighed 9½ to 12 lbs, 1 stillbirth	1
21	8	Last 3 pregnancies stillbirths, weights 6½ to 10 pounds	3
27	2	2 stillbirths, last delivered by cesarean section	2
28	5	3 neonatal deaths, weighed 11 to 12 lbs, 1 premature stillbirth	4
31	1	1 stillbirth	1
34	2	1 premature stillbirth, 1 abortion, diabetic coma	2
39	3	1 stillbirth at term	1
40	1	1 stillbirth, premature	1
41	6	3 miscarriages	3
43	5	4 stillbirths, premature twins, neonatal deaths	6
5 Spec	7	7 stillbirths and neonatal deaths, no living children	7
12 Spec	11	2 stillbirths, 1 abortion	3

The gravidity of these patients when first observed at the Sloane Hospital and the number of living children at the time are shown in Tables IV and V. Seven of the childless patients were multiparas, the others, primiparas.

Table VI, giving height and weight, shows a tendency to shortness of stature in these diabetic women. There is not, however, a conspicuous preponderance of obesity.

COURSE AND MANAGEMENT

The antepartum complications in this series are of striking interest. Especially noteworthy is the great liability to late toxemia. In the 12 who evidenced a complicating toxemia, the blood pressure ranged from 150 to 180 millimeters mercury systolic, and 90 to 120 millimeters mercury diastolic, the average being 166 millimeters mercury systolic and 105 millimeters mercury diastolic. Albuminuria was either absent altogether or rose to 8 per cent

TABLE IV.—GRAVIDITY AT FIRST DIABETIC PREGNANCY (SLOANE)

Gravidity	Cases
1	17
2	7
3	7
4	8
5	3
6	4
7	3
8	2
9	2
12	2
2 (private)	1

TABLE V.—LIVING CHILDREN AT TIME OF FIRST SLOANE DIABETIC PREGNANCY

Living children	Patients
1	10
2	5
3	6
4	3
5	3
6	1
7	1
8	1
none	24
2 (private)	2

TABLE VI.—HEIGHT AND WEIGHT OF DIABETIC PREGNANT WOMEN

Height	Weight								Total
	100	100-119	120-139	140-159	160-179	180-199	200	2	
5'		1	1						2
5' 1"			2				1		3
5' 2"		2	3	5					10
5' 3"			1			1			2
5' 4'		1					2		3
5' 5'					3				3
5' 6'				2					2
222	2	3	2	2	2		2	18	31

before delivery. This striking association of diabetes in pregnancy with the vascular type of toxemia may have peculiar significance which will be discussed in a further paragraph. Other antepartum complications seem less important and are relatively infrequent.

The management of this group of diabetic pregnant women was not consistent. Some were private patients who were admitted for delivery only and had, therefore, incomplete hospital records. Others were emergency admissions for delivery only. There was a group of unco-operative patients whose care had

TABLE I—OUTCOME OF PREGNANCIES

Births	No	Per cent
Living	38	56.7
Stillbirths neonatal deaths and spontaneous abortions	15	22.4
Terminated	14	20.7
	67	99.8

toxemias of pregnancy and in those pregnant diabetics who developed toxemia or who had either stillbirths or edematous giant infants adds further support to these theories

The greatly increased liability to intra uterine death is typical of diabetes. The cause is not yet known. It may be associated with the vascular type of toxemia with hypertension, with hydramnios, or possibly with disturbed function of the endocrine glands concerned in reproduction. Hyperglycemia and ketosis definitely promote fetal death. Maternal hypoglycemia as a cause of fetal death seems unlikely. Skipper states that a moderate fetal hypoglycemia is frequent in diabetes.

The fetus is often macerated. No characteristic changes in the placenta have been described. Fetal anomalies are said to be much more common in diabetes, among these being monsters, congenital heart lesions, meningocele, mongolian idiots and gastro intestinal atresia. We observed none of these in our series.

The question of the inheritance of diabetes is not yet settled. According to Joslin and associates, the disease tends to be transmitted as a recessive mendelian trait. More than one parent or hereditary carrier must therefore be concerned in its transmission.

PERSONAL OBSERVATIONS

As an addition to the body of the statistical and other studies on the subject we present the experience of a large obstetrical clinic in the management of diabetes in pregnancy within the insulin era. During the first 14 years of this era, 56 patients with diabetes mellitus were observed in 67 pregnancies at the Sloane Hospital for Women. Of these, 40 patients were ward with 46 pregnancies, and 16 were private with 21 pregnancies. The outcome of the pregnancies is shown in Table I.

TABLE II—FAMILY HISTORY

Maternal only	Fts.	Paternal only	Fts.
Diabetes alone	1	Diabetes alone	1
Diabetes with heart trouble	1	Diabetes with heart trouble	1
Diabetes with goiter	1	Diabetes in uncle and relative	1
Hypertension and asthma	1	Cerebral hemorrhage in father	1
Heart trouble in mother and kidney trouble in sister	1	Gangrene of foot amputation	1
Foot amputation death	1		1
	7		5

Maternal and Paternal in same family	Fts.
Diabetes in father and heart trouble in mother	1
Heart trouble in father and diabetes stroke in mother	1
Heart trouble in father and heart trouble in mother	1
Stroke in father and kidney trouble in mother	1
Nephritis in father and brother and stroke in mother	1
	5

Among the diabetics in the Sloane Hospital the percentage of stillbirths from all causes was 28.0, this is in contrast with the percentage of stillbirths in all deliveries, which was 4.2.

Family history. The familial tendency to diabetes is well shown in the following tables. It will be noted that of 17 patients in whom a family history is known, 10 gave a history of familial incidence of diabetes: 3 in the father, 1 in a paternal uncle, and 6 in the mother. In addition to diabetes, 1 parent in 2 cases suffered amputation of a foot. Cardiovascular disease was strikingly frequent. The incidence might be even higher as a number of patients were entirely ignorant of their family history.

Personal history. The personal history does not suggest that infection is an important factor in the etiology of this group of cases. On the other hand, it is of interest that there were 5 cases of hyperthyroidism. The age range of onset of the diabetes was from 15 to 38 years, in 11 the age of onset being unknown and not determinable. It is a striking and perhaps exceptional observation that in none of these cases did the diabetes start before puberty. In 11 the diabetes definitely started in pregnancy.

The previous obstetrical history showed that an extraordinary number of these women had stillbirths, miscarriages, or infants that died immediately after birth. Of the 56 patients 17 experienced 86 pregnancies in all, and of these 49, or 57.0 per cent, terminated in stillbirth, neonatal death or abortion. An increased liability to toxemia also revealed by their history.

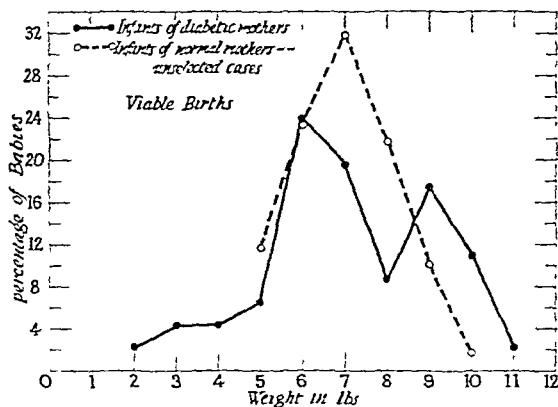
the determination of the sugar and the carbon dioxide combining power of the blood. Until the vomiting is under control, no attempt is made to supply protein or fat excepting such as may be present with the administered carbohydrate.

The next step in management is the building up of a more normal diet in which the number of calories per kilogram varies inversely with the weight of the patient. The adverse effect of obesity upon diabetes must be regarded. Furthermore, the overweight patient has the added risk of toxemia of pregnancy and in our experience an increased fetal mortality. In the obese, no measure seems to us of more importance in reducing maternal morbidity and fetal mortality than loss of weight during gestation. Even in the undernourished patient an attempt is made to limit the gain of weight during pregnancy to 25 pounds.

In the second trimester, once regulation has been established, there is generally little change in the basic requirements of diet and insulin. In 3 of our patients, however, tolerance decreased, and quite abruptly. This emphasizes the importance of a strict watch over the patient in this period, at intervals of not more than 7 to 10 days.

Between the sixth and ninth months marked changes in tolerance are to be expected. These vary in degree and in time of appearance with the individual patient. For this we lack an adequate explanation. In our series the charts of 20 patients gave data sufficient to permit evaluation of tolerance. In 9 of these there was very definite improvement as term approached, but in 7 there was just as marked a decrease in tolerance. This fact is very important in therapy. Only 4 of our patients showed an apparently unchanged tolerance throughout pregnancy. Decline in tolerance over a short period of time, if not promptly treated, may result in destruction of the fetus. It is important to remember that normal laboratory findings are not a guarantee that the diabetes will remain under control.

With regard to the fetus, hyperglycemia and acidosis are a greater threat than hypoglycemia. Of 5 patients with acidosis, 4 bore macerated stillbirths or miscarriages. Four-



Graph showing viability and weight of babies of diabetic mothers

teen of our patients had hypoglycemic reactions, some reaching coma. The time of these reactions with reference to gestation was from the second month to the day before delivery. All these 14 patients bore living babies. In view of these observations we are inclined not to be unduly concerned in the presence of maternal hypoglycemia.

An increase in tolerance for glucose is often noted at the time of labor. As has been pointed out by others, this may result from the increase in activity of voluntary muscles and from uterine contractions. The insulin requirement of a given patient is often reduced materially at this time, a circumstance calling for a reduction in its dosage in order to avoid possible hypoglycemic reactions during labor. It is our practice to decrease by half the initial dose of insulin at the onset of labor, giving additional insulin as indicated by the results of study of the sugar of the urine and blood and the carbon dioxide combining power. In 2 patients with hypoglycemia in labor, the fetal blood taken at the same time showed an extremely low level of sugar. Clinically, however, these infants behaved normally and showed no evidence of hypoglycemia.

Labor and puerperium Labor and the puerperium give rise to peculiar problems in the diabetic. Labor is critical. Anesthesia, especially with ether or chloroform, tends to induce coma. The exertions of parturition have a like effect in reducing the reserve of

TABLE VII—FETAL DEATHS

Patient No	Antepartum care	Cause of fetal death	Comment
3-17774	None	Diabetes?	Abortion. Emergency admission. Not registered in Sloane Hospital
6-10024	1 month	Diabetes	Premature 7 mos. neonatal death
7-81820	None	Prolapsed cord	Admitted at term. Full term stillbirth
9-85392	Unco-operative	See comment	Complications. Iues toxæmia fibroids diabetes premature separation of placenta
10-85674	Throughout	Bandl's ring	Antenatal death. craniotomy
10-271202	Unco-operative	Diabetes	Neglect on part of patient. Treatment in 7th month then none until admitted for delivery
11-472118	Elusive and quiet?	See comment	Complications hyperthyroidism large fibroids diabetes. No diabetes in Sloan. Admitted for delivery only
12-450731	Adequate	Fibroids	Spontaneous abortion. Multiple fibroids hysterectomy advised
15-10023	None	Diabetes	Emergency admission. premature birth. neonatal death. impending coma
30-5644	None	Diabetes	Complications. Iues and diabetes. Full term macerated stillbirth
36-10327	Private	Diabetes	Diabetes apparently controlled. Fetal death during actual delivery. Poorly developed full term infant weighing 1,400 gms
39-456755	Private	Unco-operative see comment	Complications. hypertension cardiac renal disease overweight diabetes not controlled at birth
40-4040	1 month	Diabetes	Premature stillbirth. Diabetes not controlled
43-49046	Private-none	Diabetes	Spontaneous abortion. Acidosis and infection. Diabetes not known until patient was admitted in coma
57-456725	Private adequate care	Diabetes	Acidosis. Cesarean section (flat pelvis) macerated stillbirth term

been inadequate for this reason. Only 21 patients had been managed for adequate periods by the accepted methods at the Sloane Hospital. These periods varied from the full 9 months of gestation to a minimum of 2 months.

The fetus. In this series there were 11 still births and neonatal deaths and 4 spontaneous abortions. The causes of these accidents are set forth in Table VII.

With regard to the size of the fetus of the diabetic mother, our experience as illustrated by the accompanying graph showing viable births, does not bear out commonly accepted ideas. The graph shows that the child of the diabetic mother is as likely to be underweight as overweight. Of the viable births 12.2 per cent were underweight and 26.5 overweight. Among the babies of an equal number of unselected normal mothers 18.0 per cent were overweight. In the zone of weights between 5 and 8½ pounds there seems to be a slight preponderance of large babies in the group of normal as compared with diabetic mothers.

In our series, 41 were delivered normally or by means of forceps. Of these 11 were still births or neonatal deaths: 5 premature and 6

at term. The mode of delivery in the 11 was normal in 5, by forceps in 5 and cesarean section in 1. In 5 of the stillbirths the fetal weight was 5 pounds or less, in 3, from 6 pounds 14 ounces to 11 pounds 11 ounces. Two of the deaths were due to obstetrical causes, namely, prolapsed cord and Bandl's ring. 1 was due to toxemia.

Treatment. During pregnancy the diabetic patient presents several therapeutic pitfalls. The vomiting of early pregnancy augments the danger of diabetic acidosis, so that a serious ketosis may develop rapidly. In some such cases abortion may occur before coma. For this reason the regulation of diet and insulin in the first trimester may be difficult or even impossible. Here a high carbohydrate intake is best adapted to the treatment of both the ketosis of diabetes and the vomiting of pregnancy.

Regardless of the previous diet of the patient it has been our general practice to attempt to supply 200 grams of carbohydrate daily to the diabetic patient with vomiting of pregnancy. This is given in 5 or 6 feedings at 2 hour intervals and insulin is given as often as indicated by the results of urinalysis and

the child in advance of term, the total mortality in our cases was 28.3 per cent. Included in these figures are 4 spontaneous abortions in 9 inadequately treated diabetic mothers, and 4 with serious added obstetric complications such as Bandl's ring, prolapsed cord, and large fibromyomas. Excluding cases of this kind the corrected mortality is 3.7 per cent, a figure differing little from that of the general hospital admissions

SUMMARY AND CONCLUSIONS

In an experience with the care of 56 patients with diabetes in 67 pregnancies we have been impressed with certain phases of the condition. In the first place, a family history of diabetes occurred in 17.8 per cent. Of equally common occurrence was a family history of vascular disease.

In none of the patients did the disease begin before puberty, so far as we could ascertain. In 15 cases, a larger proportion than is usually reported, the disease began during pregnancy.

The past obstetrical history is striking. There is a story of repeated stillbirths, abortions, and neonatal deaths. The reproductive capacity of these patients is low. The incidence of vascular disease and hyperthyroidism is high.

Under the conditions of a well organized clinic, the diabetic mother may be carried through pregnancy with little added risk.

Further, there is a reasonably good chance of a viable infant provided the maternal care is adequate. Conversely, the fetal mortality in diabetes not adequately supervised and treated remains high. The striking liability of the diabetic woman to late toxemia should be emphasized. This seems a significant association. The internist has long surmised that vascular disease with hypertension is related to diabetes, and has noted the tendency of diabetes and hypertension to dwell in the same individuals and families. Further, the relation of late toxemia of pregnancy to vascular disease has been established. For this reason, the frequent association of diabetes with the vascular types of pregnancy toxemia is of more than casual significance.

The fetus of the diabetic mother is quite as likely to be underweight as overweight.

In our judgment the routine performance of cesarean section in uncomplicated maternal diabetes is unwise. This operation should be reserved for those cases in which there is a supporting obstetric indication.

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TABLE VIII—MODE OF DELIVERY

Spontaneous	No
Instrumental	25
Cesarean sect on	16
Dilatation and curettage	8
Hysterotomy and sterilization	10
Spontaneous abortion	4
	5
	67

glycogen and alkali, thus promoting hypoglycemia, acidosis, and its consequences

In our cases the hazard of infection seems to be as pronounced as in those reported elsewhere. There was a puerperal morbidity of 41 per cent, as judged by our standard—a temperature of 100.4 degrees for two consecutive readings after the first 24 hours following delivery. This diagnosis was made in 14 with out any specific infection having been recognized. Two were diagnosed as endometritis, 1 as pyelitis, 1 as thrombophlebitis and 2 breast abscess.

Delivery. The mode of delivery in the 67 pregnancies is shown in Table VIII. Of the 67, 31 were delivered at term, 17 were premature, and 2 were overdue.

Among the 15 fetal deaths in both groups are included the spontaneous abortions. Of the 9 fetal deaths in the first group we consider diabetes the sole cause in 6. In the remaining 3 there were additional factors such as fibroids, lues, toxemia, and obesity.

In the second group that of adequately controlled diabetics, 6 fetal deaths occurred. Two were premature stillbirths. In 1 case there were multiple fibroids, in another fibroids and hyperthyroidism. In the 2 remaining, Bandl's ring and prolapsed cord. It will be noted that when fetal death occurred in diabetics adequately controlled a factor other than the diabetes was present.

Cesarean section. The question of cesarean section in diabetes is of special importance. It should have discussion from the standpoint of the mother and of the fetus. In none of our cases was cesarean section undertaken because of the diabetes alone. The indications for the operation in these patients were for pelvic disproportion, 3; elective following stillbirth caused by Bandl's ring in a previous pregnancy, 1; for uterine inertia, 1, followed by a

second section in the same patient in a later pregnancy, for sterilization, 2.

Our experience inclines us to hesitancy in advising termination of pregnancy by cesarean section in the diabetic. In the first place if this measure were adopted generally in all cases in which the diagnosis of diabetes in pregnancy might be made, a way would be opened to the commission of numerous errors. Among possible mistakes, that of diagnosis is not unimportant. Without adequate experience and laboratory equipment examples of renal glycosuria, lactosuria or non-diabetic acidosis in pregnancy may be mistaken for true diabetes and the patient subjected to needless surgical hazard.

Since we have had no maternal deaths in diabetes during pregnancy, the puerperium, or the follow up we can find no strong argument for radical methods of delivery in this disease, at least from the standpoint of maternal security.

At this point one might recall the fact that the general maternal mortality for this operation as given by P. H. Bland¹ is 6.5 per cent.

These facts tend to discourage the early or artificial termination of pregnancy as a general measure in diabetes.

The fact that a diabetic mother loses her fetus is not necessarily proof that the metabolic disorder is responsible for the unsuccessful pregnancy. In all such instances one should investigate such frequent causes of fetal death as toxemia, lues, hyperthyroidism, vitamin deficiency, uterine fibroids, or hormonal defects any of which may be co-existent.

On the side of the fetus cesarean section is a more debatable matter. Can this operation diminish the frequency of fetal death in diabetes? Since it has been stated that the obstetrician's answer to diabetes is cesarean section shortly after viability to save the child, the ordinary fetal risks of this procedure might be recalled. It should be considered that every baby delivered by this dictum is premature. In a review of 300 cases of prematurity, Wilcox reports a gross mortality of 25 per cent regardless of the method of delivery. Without interrupting the pregnancy in the interests of

authors may be reconciled when we remember that one speaks of the condition of things in the living subject and another in the dead. The knowledge of one is gained in the clinic, of the other in the dissection room." It was then that Henle wrote that deductions based upon frozen sections were of no value as both the consistency and the position of the uterus were altered after death, for in life the tone of the muscles and the filled blood vessels were of importance in establishing the position of the uterus

In 1863 Luschka described the organized muscle fascia rich in elastic tissue that makes up the broad ligaments together with the many blood vessels and lymphatics in the lower part of the ligaments. He traced out the formation of the muscle fibers from the folds of Douglas to their insertion in the lower end of the uterus and vagina which "helped to fix the position of the uterus," and called these ligaments the "retractor uteri." Virchow demonstrated later that many of the muscle fibers in the uterosacral ligaments extend along the sides of the uterus and join with muscle fibers from the anterior face of the uterus to make up the thin layer of muscle in the uteropubic fascial plane on which the bladder rests. The position and axis of the uterus continued to be the subject of discussion and debate

It was in 1880 that Kocks when a *Privatdozent* in the University of Bonn, wrote his monograph in which he discussed the normal and pathological position and shape of the uterus, and its mechanics. In this discussion, today a classic in gynecology, Kocks described the positions of the uterus, answering the arguments for and against the various displacements as found in frozen sections or as found on palpation in the living. His opinion was that the uterus has no absolute, but a relative, position. His arguments against the positions as found at postmortem, are that in the living (1) there is a positive abdominal pressure, (2) that the influence of inspiration and expiration must be considered, (3) in the ligamentous apparatus of the pelvic organs the connective tissue which binds them together has a certain degree of "turgescence" which is lost after death, and finally (4) the

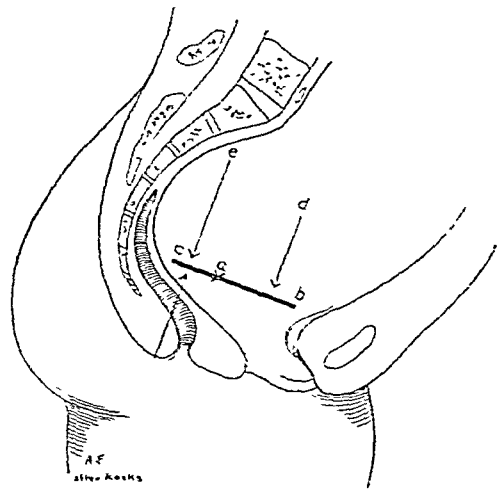


Fig 1 Cardinal transverse horizontal axis (From Kocks)

muscle elements in the ligaments act with sufficient force in the living to influence the position of the uterus.

Kocks described the mechanics of the pelvis and says, "The bases of the broad ligaments build the axis of the uterus and because of their importance should be called the cardinal ligaments. They build, according to my thinking, the material 'substrat' of the axis and account for the normal anteversion of the uterus." He called the base of the broad ligaments the "cardinal transverse horizontal axis" and said on this axis the uterus turns as on a lever with two arms (Fig. 1). The anterior longer arm (*a-b*) is the position of the uterus in young women or in nulliparae. The posterior shorter arm (*a-c*) is the position of the uterus after pregnancy has occurred. The uterus then has a longer axis upward due to its increase in size and sinks lower toward the vaginal outlet as a result of the softening of the pelvic tissues, and it is not as sharply bent forward as in a nullipara. The intra-abdominal pressure is greater on the axis *a-c*, but may be equal in both axes under certain conditions

In a summing up of the position and mechanics of the uterus, Kocks gives such an exact and concise description, I will quote in its entirety. He says: "The upper pelvic floor consists of the bases of the broad ligaments,

THE UPPER PELVIC FLOOR AND ITS IMPORTANCE IN TOTAL ABDOMINAL HYSTERECTOMY

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IN 1888 von Bardeleben, of Jena, reviewed the literature pertaining to gynecology from the time of Leonardo da Vinci ("Der Allseits Median Schnitt") up to and including his own period and characterized the writings "with few exceptions" up to the middle of 1800 as "so gut wie nichts." He states that in the year 1854 there were published three papers by three different physicians, each in a different country which laid the foundation of gynecology. Kohlrausch published in Leipzig *Zur Anatomie und Physiologie der Beckenorgane*. He said that the position of the uterus was dependent upon the fullness of bladder and rectum and that the cervix was fastened to the bladder by a light reticular plane of connective tissue. The second paper was printed in the *Gazette médicale de Paris* and was an exposition by Cruveilhier on the autopsy of a young woman who had died following the repeated use, for several days, of an indwelling catheter introduced into the uterus to correct a sharp antelexion. Cruveilhier said that disease produced malposition of the uterus but that malposition existed without symptoms and did not produce disease. In the discussions with Arvard at this time, Cruveilhier gave his opinion, based upon autopsies, that there was no established normal position for the non-pregnant uterus. Arvard, who had palpated and moved the uterus in the living, and found that it would immediately return to position, claimed that an angle of 75 degrees with the horizon was the normal position for the uterus. The third paper was written by Matthews Duncan, and appeared in the *Edinburgh Medical and Surgical Journal* of that same year. It was entitled "On the Displacement of the Uterus." Duncan affirmed that, "Death was not a good criterion as so much depended upon muscular tonicity and vascular turgescence which dis-

appeared with life." Duncan also wrote "A uterus that is not mobile is in a pathological state." This is the beginning of the study of anatomy, physiology, and pathology of the pelvic organs in women.

In the *History and Bibliography of Anatomic Illustrations* written by Ludwig Choulant he writes "The great universal genius Leonardo da Vinci illustrated the fetus in its natural position from direct personal observation and not until William Smellie in 1754 and William Hunter in 1774, both of London, published their monumental volumes do we actually find illustrations of the fetus *in utero* which were really observed and faultlessly reproduced from an anatomical point of view." There are even fewer illustrations of the non-pregnant uterus, but da Vinci has one showing graphically the blood vessels of the uterus, and Versalius has one plate in his work on the human body of the fusion of the muellian ducts, and the uterus complete with the cervix, vagina and urethra. In 1754 William Smellie published with the set of anatomical tables his "*Practice of Midwifery*." In this work is one illustration of real historic value in gynecology as it shows the uterus supported on the vagina as it was at that time commonly believed to be. It is of interest to note that the artist (Pieter Camper) drew the course of muscle fibers from vagina to broad ligament. These colpopaginal muscle fibers were not utilized in plastic work on the vagina until more than a hundred years later.

While so little was done for gynecology by the anatomists immediately following Smellie, the study of pelvic conditions in women was greatly stimulated by the publications of Kohlrausch, Cruveilhier, and Duncan. The greater part of the research was done on frozen sections and naturally to a much less degree on the living. The reports were so at variance that Marion Sims wrote "I would say therefore that some of the discrepancies of the

authors may be reconciled when we remember that one speaks of the condition of things in the living subject and another in the dead. The knowledge of one is gained in the clinic, of the other in the dissection room." It was then that Henle wrote that deductions based upon frozen sections were of no value as both the consistency and the position of the uterus were altered after death, for in life the tone of the muscles and the filled blood vessels were of importance in establishing the position of the uterus.

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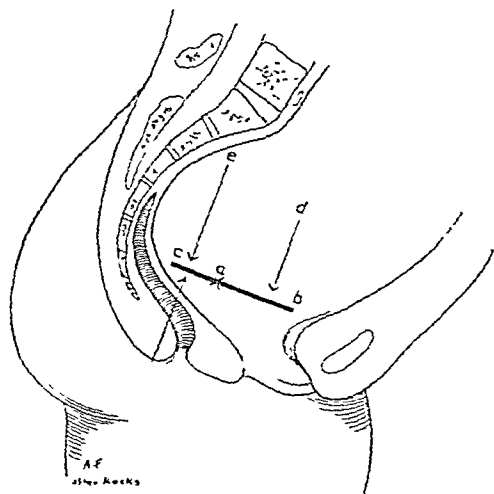


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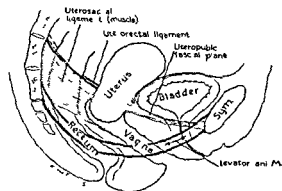


Fig. 2 Uterosacral ligaments uteropubic fascial plane and the levator ani muscle

the uterine end of the ligamentum sacro uteri, the ligamentum vesico uteri, the posterior wall of the bladder, and the anterior wall of the rectum, all of which are bound together by connective tissue fibers and covered with peritoneum and inserted into the uterus at the height of the internal os. The finger thick bases of the broad ligaments form the true lever (*Drehpunkte*) for the mechanics of the uterus."

Two years after Kocks monograph Berry Hart of Edinburgh published his atlas and at about the same time Savage of London, brought out his beautifully colored plates of the pelvic organs in women. Berry Hart described the fibromuscular tissue of the uterosacral ligaments as alike in structure with the broad ligaments with which they are joined differing only in the greater proportion (Fig. 2) of muscle in the uterosacral ligaments and in the great amount of elastic tissue through out the broad ligaments and the connective tissue at their base. The uterosacral ligaments have at their upper border a flat fold of muscle fascia that extends from the uterus to the rectum and if one wishes to be anatomically correct they should be called uterorectal ligaments. The true uterosacral ligaments lie just below these two folds and extend (on each side of the rectum) from about the third sacral vertebra to be inserted into the posterior surface of the uterus at the height of the internal os. This insertion of the ligaments extends down the entire posterior cervix and then down to be inserted into the posterior wall of

the vagina. It is due to the thickness of these muscles and to their insertion into the posterior cervix and vagina that the uterosacral ligaments become the strongest factor in the upper pelvic floor that influences the position of the uterus. Luschka rightly termed them the "retractor uteri."

The elastic tissue in the broad ligaments allows of movement of the tissues themselves and of displacement of the uterus laterally or posteriorly or for growth of the uterus upward without disturbance or injury of the structures within the broad ligaments. The anterior portion of the upper pelvic floor is composed of light reticular fascia and the uteropubic fascial plane on which the bladder rests is made up of connective tissue with only a thin layer of muscle and almost no elastic tissue. It is for this reason that the powerful muscles in the uterosacral ligaments can influence the position and direction of the descending head in labor as proved by x ray studies made by Caldwell and Moloy. It is also the reason why the most common and often the only visible injury after labor is a resulting cystocele due to the pressure on the uteropubic fascial plane which splits longitudinally and its torn edges (so erroneously called the "pillars of the bladder") stretch apart from the continued intra abdominal pressure. The bladder forced by prolonged pressure from above slips through the gap in the torn fascial plane just as a loop of intestine does in a hernia.

The connective tissue in the base of the broad ligaments was well described first by Savage who wrote "The uterine system may be conceived as having been thrust into the pelvis between the rectum and bladder and there fixing itself by cellular attachments to every available part of the pelvic cavity." Savage was also the first to note that infection in the broad ligaments long remained local without involvement of the ureter, rectum, or bladder. He also showed that the uterine cellular system is continuous at its periphery with every part of the subperitoneal cellular tissue at the lower part of the abdomen.

The beautiful illustrations in the atlas by Sappey of his work on the lymphatics of the body depict the glands lying in the broad

ligaments and the course of the lymphatics from the uterus. The importance of removing these glands in the broad ligaments was stressed by Wertheim when performing hysterectomy for cancer of the cervix.

In 1885 Freund published his work on the connective tissue of the pelvis and the result of an inflammation that involves it, and Testut later described the "phlegmons" or abscesses of the broad ligaments with the four routes of approach: (1) Vaginal route—by incision direct without opening the peritoneum; (2) perineal route of Hegar and Saenger that crosses the ischiorectal fossa and levator ani; (3) parasacral route of Zuckerkandl and Wolfer and is made at the border of the sacrum upon the sides of the rectum; (4) abdominal *sous peritoneale* of Pozzi

The sympathetic ganglia lying on the posterior leaves of the broad ligaments had been demonstrated as early as 1867 by Frankenhauser, their location he believes accounts for the fact that operations on the posterior pelvis produce more shock than operations on the anterior pelvis. Undoubtedly this fact explains why less shock is associated with a vaginal hysterectomy than with an abdominal hysterectomy for in vaginal hysterectomy there is not nearly so great an invasion and injury by clamps to the broad ligaments as there is in the abdominal operation.

In 1894 Mackenrodt, of Berlin, wrote concerning the normal and pathological positions of the uterus and he described the tissues of the broad ligament which he called the *Ligamentum transversale colli*. This ligament (*band*) has been the subject of much discussion and several papers have been written denying its existence, the reason being, I believe, a misconception of Mackenrodt's use of the word *band*. The illustration published in the same issue of the *Archives fuer Gynaekologie* certainly leaves no doubt that Mackenrodt intended the entire broad ligament as the *Ligamentum transversale colli*. Mackenrodt's exposition of the tissues in the broad ligament adds nothing to the work of the previous writers but is of value inasmuch as he maintains that the broad ligaments are the supporting structures of the uterus. The objection is often made that the tissues described by both Kocks and Macken-

rodt are not true ligaments, and this may explain why their studies have not received more recognition.

In 1899 Waldeyer, of Berlin, in his great work *Das Becken* showed by illustrations the embryological and anatomical formation of the structures composing the broad ligaments: (a) The three ligaments that lie on each side of the uterus in the folds of the broad ligaments begin early in embryological life as two strands of tissue that cross (one on each side) the muellerian ducts. Later in fetal life having derived muscle from the outer coat of the uterus, the anterior portion of each strand of tissue becomes a round ligament, similar to the "gubernaculum" of John Hunter, and composed of muscle and elastic tissue in its upper half and of connective tissue in the lower half where it is attached to the pubic bone and labia majora. Berry-Hart, in his interesting work, has traced the physiological descent of both the ovaries and testes in the human fetus and says the descent of the ovary is analogous to that of the testes, but its further descent in the pelvis is checked by the broad ligament and the uterus. In the adult female, the ovaries lie on the posterior aspect of the broad ligament, on the lateral pelvic wall in front of the sacro-iliac joints, immediately below the ileopectineal line, and with the ureter curving behind. The pelvic ectopia testis is analogous to the normal position of the ovaries. The inguinal and lateral ectopia ovarii are normal stages for the testes. Waldeyer showed that the upper part of the strands of embryonic tissue take their muscle from the uterus and are continued as the ovarian ligament and then as the infundibulo pelvic ligament. If the ovaries are to be left *in situ* when a hysterectomy is performed, the ovarian ligaments (by virtue of this muscle) should be fastened to the vaginal or cervical wound before it is closed.

Luschka (in 1863) first called attention to the proximity of the ureter to the ovary just as the ureter is about to enter the broad ligament where it lies superficially under the posterior leaf of the broad ligament to which it is attached. The ureter continues directly under the hilum of the ovary to which it is often adherent and as it emerges from the broad

ligament lies close to the vaginal plexus of veins. The origin of the base of the broad ligament is shown by Waldyer to be from the uterus at the height of the internal os. The muscle is derived from the outer muscular coat of the uterus as shown by Pietro Sue (in 1600). Its fibers extend from the uterus transversely and obliquely to the pelvic wall, and laterally are continuous with the adjacent tissues. There is no line of demarcation between this muscle and the uterus and no attachment of the broad ligament to the uterus as it is sometimes stated in textbooks. The connective tissue sheaths of veins, lymphatics, blood vessels, and ureters run more or less obliquely from back forward and from above downward through the broad ligaments strengthening them but not fixing the tissues rigidly, for the great amount of elastic tissue present in the folds of the ligaments permits considerable movement of these sheaths and allows for the growth of the uterus upward in pregnancy or for lateral or posterior displacements of the uterus or for its enlargement by tumors.

An excellent description of the external appearance of the broad ligament is given by Testut who says "The broad ligament consists of two folds of peritoneum as they leave the sides of the uterus in close apposition one to the other for a part of the distance to the lateral walls of the pelvis. They form a sheet of tissue irregularly quadrilateral the upper border of which is free, thin, and mobile, the other borders of which are thick and attached to the lateral wall of the pelvis and to the upper pelvic floor and to the sides of the uterus. This sheet of tissue forms on each side of the uterus—two wings to the uterus, as it were, and consists only of the broad ligaments. (a) The anterior face of the broad ligament looks forward and downward, (b) the posterior face, which is larger, looks backward and upward and envelops part of the ovary and its ligament, the mesosalpinx and the hooded cap of the ovary, (c) the superior border encloses the fallopian tube, ovary, and its ligaments, (d) the inferior border, the thickest of the four borders, rests on the upper pelvic floor. (It is in close contact with the lateral cul de sac of the vagina. It contains the ureter and the horizontal part of the uterine artery), (e) the

internal border, thick and short, rests at the side of the uterus, it contains the ascending part of the uterine artery and the venous plexus, (f) the external border, relatively thin, rests at the lateral wall of the pelvis. In the upper part between the pavilion of the tube and the external extremity of the ovary it is free and *flottant*. Below the ovary it adheres closely to the pelvic wall near the obturator internus and its aponeurosis and at the extremity of the ovary it continues as the infundibulopelvic ligament, the ilio ovarian ligament, or the lumbar ovarian ligament. It lodges the ovarian artery and vessels and contains smooth muscle (Luschka's 'retractor of the fallopian tube'). It crosses the iliac vessels, then the border of the psoas muscle to the lumbar region. Anatomically the broad ligament is composed essentially of two leaves of serous tissue with a sheet of smooth muscle united one with the other by a bed of cellular vascular tissue. A sagittal section shows it consists of (a) the mesosalpinx—two leaves of peritoneum between which is a bed of cellular elastic tissue and some blood vessels, (b) the base of the broad ligament—lymphatics, cellular tissue, blood vessels."

The relation of the structures in the broad ligaments to one another and to the adjacent structures is shown in an admirable dissection (Fig 3) made by Sellheim. Comparative anatomy of the female pelvic organs has seldom been described and never more beautifully illustrated than in his dissections (Fig 4). If we bear in mind, as Blair Bell has said, the important fact that there are no aponeurotic fascias except in relation to muscle surfaces (Fig 5) and that when fascia comes into relation with blood vessels, lymphatics or nerves it forms fibrous bands and sheaths. This increases the supporting power of the structures in the broad ligaments. Add to this the fact that the levator ani (Fig 6) arises from the back of the pubic bone and the fascia on the internal surface of the compressor urethrae with which its fascial coverings are blended, that its superior fascial covering is attached to the aponeurosis of that of the muscles above, and posteriorly its aponeurosis is adherent to the ischial spine and continues to the side and anterior surface

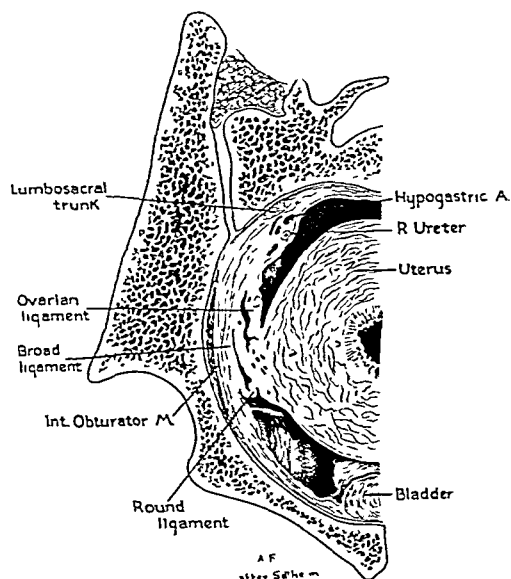


Fig 3 Cross section at about the first sacral vertebra showing the broad ligament and its relation to the obturator internus muscle, etc (After Sellheim)

of the coccyx where the fascias from either side unite in the midline. Thus the whole upper floor forms a united structure for the support of the uterus.

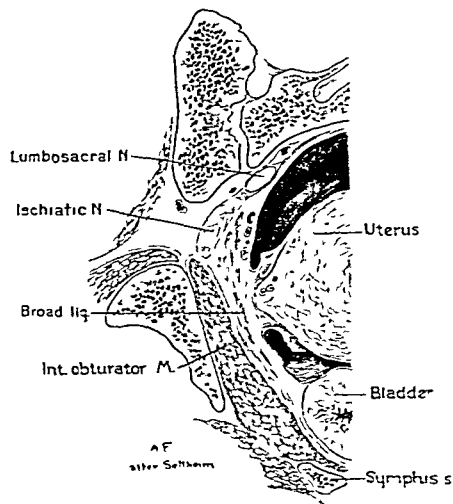


Fig 4 Cross section 2 centimeters below that in the preceding illustration showing the broad ligament and its relation to the obturator internus muscle and the sheaths of the nerve trunks (After Sellheim)

The tissues in the broad ligament vary greatly even in young women, depending upon the age, general constitution, and muscular development. Their vascularity and elasticity are greatly increased during pregnancy. In the normally developed young woman and in

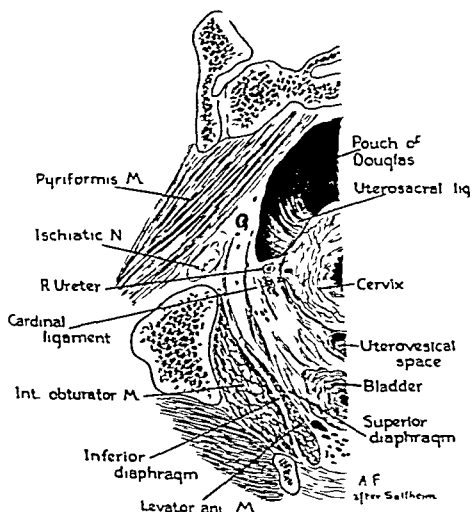


Fig 5 Cross section 2 centimeters below that in the preceding illustration showing the cardinal ligament and its relation to the pyriform, internal obturator, and levator ani muscles, the sheaths of nerves, ureter, and blood vessels (After Sellheim)

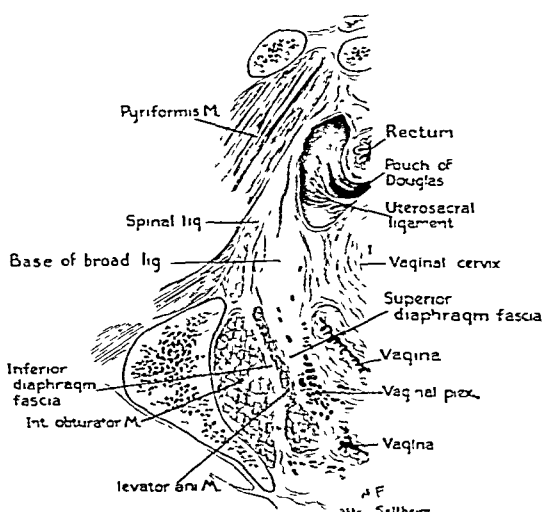


Fig 6 Cross section 2 centimeters below that in the preceding illustration showing the base of the broad ligament and its relation to the pyriform and levator ani muscles, the spinal ligament and the uterosacral ligament (After Sellheim)

ligament lies close to the vaginal plexus of veins. The origin of the base of the broad ligament is shown by Waldeyer to be from the uterus at the height of the internal os. The muscle is derived from the outer muscular coat of the uterus as shown by Pietro Sue (in 1600). Its fibers extend from the uterus transversely and obliquely to the pelvic wall, and laterally are continuous with the adjacent tissues. There is no line of demarcation between this muscle and the uterus and no attachment of the broad ligament to the uterus as it is sometimes stated in textbooks. The connective tissue sheaths of veins, lymphatics, blood vessels, and ureters run more or less obliquely from back forward and from above downward through the broad ligaments strengthening them but not fixing the tissues rigidly, for the great amount of elastic tissue present in the folds of the ligaments permits considerable movement of these sheaths and allows for the growth of the uterus upward in pregnancy or for lateral or posterior displacements of the uterus or for its enlargement by tumors.

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nulliparae the broad ligaments are soft, firm, and only moderately yielding to pressure, unless examined when the individual is under an anesthetic. In multiparae the tissues are thicker and less resistant. In the aged the muscles are much thinner and the uterus is more readily displaced downward, due not always to torn muscle, but as well to the loss of the very large amount of elastic tissue normally present in younger women. If fibroids have developed in the uterus, the tissue of the broad ligaments may have the same firmness as the uterine tissue and when taking out such a uterus in an abdominal hysterectomy it may be as hard to cut as gristle. The effect of inflammation or suppuration in the parametrium may be to leave a chronically thickened tissue across the base of the upper pelvic floor. The development of connective tissue and its supporting effect may be seen after the radium treatment of a cancer of the cervix, the vault of the vagina may become narrow in width and much thickened with no prolapse of the now shrunk-cervix, although perhaps below the irradiated tissues a gaping vulvar orifice with a large cystocele and rectocele bulging into the vagina may be seen. From all this it is plain that the development and character of the tissues in the broad ligaments vary greatly in the living, depending not only upon age and constitution but also upon the effect of injuries incident to labor, of loss of muscular tone and elasticity, and to inflammation or tumor growth. All of these factors should be taken into consideration before an operation is undertaken. As von Bardeleben said many years ago: "Anatomy is not the knowledge of a cadaver, nor of dead tissues, but it is a part of the knowledge we have of the living."

It was not until nearly the end of 1800 that surgeons began to use the paracervical and paravaginal tissues in repair of prolapse of the uterus. In 1887-1888 Ernst Cohn, of Berlin, published the results obtained by Schroeder and Olshausen who in such cases performed anterior or posterior colporrhaphy and in a few cases the combined operation, of anterior and posterior colporrhaphy. In 1888 Archibald Donald, of Manchester, England, for the first time, amputated the cervix and then did an anterior and posterior colporrha-

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It is important therefore in total abdominal hysterectomy, to avoid, so far as possible, injury to the structures that lie in the depths of the upper pelvic floor and to utilize the supporting tissues in closure of the wound. First, hemorrhage from the vaginal venous plexus may be avoided by ligating the uterine artery, not only where it enters the uterus, but also before the vaginal and cervical branches are given off from the uterine artery. Second, injury to the sympathetic ganglia lying on the posterior leaf of the broad ligament may be avoided by cutting down the broad ligaments close to the sides of the uterus without applying any clamp to the broad ligaments (Fig. 7). Third by cutting the uterosacral muscles and

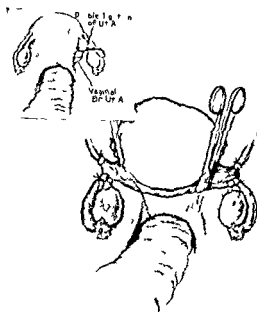


Fig. 7

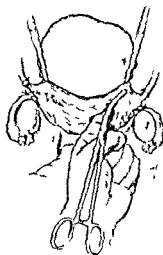


Fig. 8

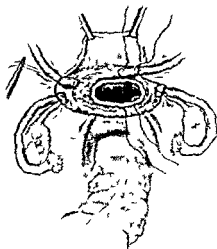


Fig. 9

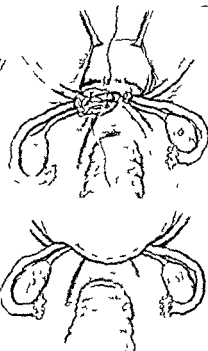
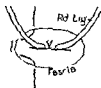


Fig. 10

Fig. 7 Uterine artery ligated at entrance into lateral wall of uterus and again beyond origin of vaginal branch from uterine artery. Scissors cutting down sides of uterus—no clamps.

Fig. 8 Finger introduced through the opening made into vagina to apply an artery clamp close to side of uterus before cutting out uterus.

Fig. 9 Sewing the round ligaments to the sutured vaginal wound.

Fig. 10 Sewing uterosacral to round ligaments and uteropubic fascial plane.

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entering the vagina (Fig 8) posteriorly, the uterus will be loosened. A finger may be introduced into the vagina (this may be done safely if vagina has been properly scrubbed, douched, and iodized), which may act as a guide for the application of clamps to the vagina, thus insuring the cutting out of the uterus but eliminating the possibility of cutting too much of the broad ligament of injuring the ureters or bladder, of cutting into the uterus, and of leaving part of the cervix *in situ*. In this the technique resembles that of the usual vaginal hysterectomy. Fourth, careful closure of the vaginal wound. This should be done in an anteroposterior direction and not from side to side for the latter might cause distortion or injury to the ureters. The technique of closure should include (a) suture of the muscle walls of the vagina (b) the attaching to them of the round ligaments (Fig 9), uterosacral ligaments, ovarian ligaments if left, and the (Fig 10) uteropubic fascial plane, (c) the covering of the wound completely and exactly with the vesical peritoneum.

CONCLUSION

1. The upper pelvic floor is made of the unstriped muscle, elastic and connective tissue derived from, or attached to the lower part of the uterus and vagina. It includes the fibrous bands or sheaths of the nerves blood vessels lymphatics and ureters lying in the broad ligaments, the levator ani and its fascial coverings which are attached to that of the compressor urethræ anteriorly to the ischial spine and to the coccyx posteriorly and which blend with the aponeurosis of the muscles which lie above it in the broad ligament.

2. In total abdominal hysterectomy it is important to employ a technique by which one may remove the entire uterus without invasion of the broad ligament.

3. The tissues of the parametrium and paracolpos should be used to ensure a firm closure of the vaginal wound and to maintain the support of the upper pelvic floor.

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BIOLOGICAL SURGERY IN TUBERCULOUS PATIENTS

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IT is a well known fact that every trauma to, or infection in, living tissue produces a reaction the severity of which depends upon whether the body is vulnerable or has been prepared by successive attacks to repel the inciting agent. For example, a primary attack of tuberculosis frequently produces in the human body an inflammatory reaction later to produce caseous lesions of varying intensity, known as the primary lesion of Ghon. The local reaction affects all the tissues and circulating fluids of the body, a fact well demonstrated by the von Pirquet test; here a positive reaction is obtained in the arm although the primary tuberculous focus may be located in the lungs.

If, however, the local caseous lesions resulting from the first attack remain quiescent and there is no other reaction on the part of the body, the patient may suffer a second attack by the Koch bacillus, resulting in tuberculosis of the bone, the lungs, the skin, or other part of the body. In the second attack, the Koch bacillus finds the tissues of the body altered—they have developed an allergy, the result of the first inoculation. The manner in which the reaction of the tissues is affected by the presence or absence of allergy is demonstrated in the production of the Koch phenomenon. In our experiment in producing the Koch phenomenon we used two guinea pigs. One of these had been successfully inoculated with a small injection of attenuated Koch bacilli a few months previously; consequently, it had a primary tuberculous lesion, in other words, a primary lesion of Ghon. The other guinea pig had received no preliminary injection of Koch bacillus and had no tuberculous focus. Both pigs were given subcutaneous injections of equal amounts of virulent Koch bacilli. The reaction in the two pigs was very different. In the first guinea pig, which had been previously inoculated with tuberculosis, in the first few days,

a black crust formed and fell off leaving an ulcerated area which was quickly filled in with cicatricial tissue. Thus the site at which the second injection had been made healed. In the second guinea pig which had received no previous injection of the Koch bacillus, the skin ulcerated within a month and the affected area became an extensive tuberculous ulcer, finally resulting in the death of the animal.

From these experiments it would seem that in the first animal, by virtue of having received a previous inoculation of the tubercle bacillus, the reaction of the plasma and circulating fluids had been modified; an allergic state developed which might be interpreted as an aggressive offensive against the new invaders. In other words, there was produced an immunization which was instrumental in curing the local lesion.

The experiment demonstrated clearly the phenomenon of Koch, namely, (1) that the primary inoculation is virgin soil free from tuberculosis, and (2) the re-inoculation in soil previously infected, caused dissimilar results: the first resulting in a caseous ulcer and the second in a cicatrix in tuberculous tissue without caseation. It is essential that the same tissue be used in both cases. The subcutaneous tissue, as in the experiment on the guinea pigs, is the most accessible and the most easily observed.

Almost every one from earliest childhood has a primary tuberculous lesion which is well tolerated. The lesion is usually in the form of a cicatrix with caseous material and with calcium salts frequently present, is about the size of a grain of wheat, and is sealed in the regional lymphatic ganglions. This sealed focus forms what is called the primary lesion of Ghon, which consists of live Koch bacilli of low virulence, and provides, during the life of the individual, substances which produce active immunization processes, like those which brought about the reaction in the guinea pig experiment.

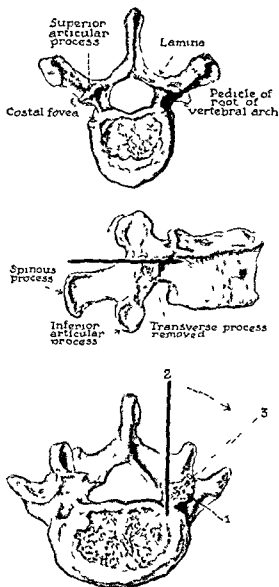


Fig 1. Diagrams showing the operative procedure. In the drawing at top it is noted that the space between the spinous process and the transverse process on one side is thoroughly exposed. Hemostasis is obtained by pressure. The transverse process is then removed by bone rongeurs with the neck of the rib as a guide. The operator inserts the perforator through the exposed base of the transverse process with the pedicle vertically through the exact center to the depth of 1 inch—a distance equal to the anteroposterior segment of the spinal foramen at this level. Care is used to avoid penetrating the spinal canal. For that reason the body of the pedicle is used. With the point of the

Endogenous re infection in man probably arises from the reactivation of a Koch bacillus deposit which has remained dormant since the initial attack. This reactivation may take place in the selfsame primary lesion of Ghon or it may occur in any other site. The later re infection causes mild infections in the blood stream which are rapidly destroyed in the blood. At times, however, tissue in a state of lowered resistance may be involved or the re infection may be so overpowering that the natural defenses of the body provided by the lesion of Ghon will be overcome. In such instances the tubercle bacilli will colonize and thrive.

For 25 years we have sought diligently to find in the various tuberculous lesions in man these tuberculous re infection nuclei which stimulate the different tissues of the body to react so unexpectedly after having attained an allergic state. Such scars or nuclei we have chosen to call successively strangulated focus, chancre and now nucleus of post allergic focal infection.

We have found these nuclei in bone tissue and in the lungs. It is in aiding in the dispersion of the substances which are developed in these foci that we base our theory of treatment. At first we used the method only in cases of bone tuberculosis, today, however, we use the method in every case of tuberculosis whether it is of the lungs, the larynx, or other organs, the only exception being tuberculosis of the meninges.

Our first studies were made with animals first with tuberculous cows, then with dogs, rabbits and finally with guinea pigs. We used attenuated cultures of the Koch bacillus for inoculation material. Our experiments were carried on in large well equipped laboratories of the Instituto Modelo de Clin

perforator in the body of the vertebra the operator further inserts the perforator at an angle of 45 degrees and to the depth of 1 inch which is generally sufficient we fill the tunnel with an autogenous graft as a hemostatic measure. The caseous portions and the intervertebral disc are avoided. The middle drawing is a lateral view of the dorsal vertebra. In the bottom drawing of lumbar vertebra we note 1 the superior articular process has been removed by bone rongeurs, 2 the perforator is inserted for the first time and is shown reaching the interior of the pedicle, 3 the perforator has been inserted a second time and now reaches the middle of the body of the vertebra.



Fig 2 C S, before operation. A cavity the size of a penny and containing fluid is shown in the right apex. There is minute, nodular infiltration in the periphery and the paratracheal ganglia on the right side are very marked



Fig 3 C S, 14 months after operation. The nucleus of post allergic focal infection had been perforated but once with a trocar. The cavity has been replaced by cicatricial tissue, the hilar and paratracheal ganglia are diminished in size, fibrotic tendency is very marked. Patient does not cough, no Koch bacilli were found in the sputum and general condition is excellent

ica Medica of Buenos Aires, under the direction of Professor Luis Agote, who was the first in the world to use only citrated blood in blood transfusions in the human. After many months of study, however, all this material had to be abandoned, since we could not follow the development of the tuberculous processes for a sufficient length of time as in the human being and also the animals for experimentation were not of manageable size

We then began to devote our entire work to the minute observation of the pathological physiology in tuberculous lesions in knees which were obtained by transverse section of the human femur and tibia, our object being to note, centimeter by centimeter, any change in consistency, color, or quality of the blood at the different levels of resected bone. We studied especially the smaller and healthier portions rather than the portions with fatty degeneration, red or gray, with caseous necrosis, cavities

After persistent search our presumption was verified. within a section of the bone, there oozed forth under pressure a small quantity of black, thick, tar-like blood from a well

defined undermined spot, about a half centimeter in diameter. In addition we noted, adherent to the clot, an area of grayish tissue, resembling cicatricial tissue. Further studies revealed that this clot contained many attenuated tubercle bacilli which had become granular. The section showed an intense, specific reaction of the reticulo-endothelial system, as in caryocinesis. In the midst of a large quantity of collagenous substance, epithelioid cells formed Koester follicles but without caseous necrosis, that is, there developed a tuberculous tissue structure with great tendency to form one scar.¹

In roentgenograms of patients with tuberculous osteo-arthritis who have been treated with rest and heliotherapy only, we were able to prove that the appearance and size of the nucleus of post allergic focal infection did not change from year to year, but that the destructive process continued to progress throughout the extent of the bones forming the diseased joints. We have devoted much

¹See Tuberculosis quirurgica. Semana méd., 1935, No 30



Fig 4



Fig 5



Fig 6

Fig. 4 L. M. 30 years old before operation. Patient has had Pott's disease for 1 year. There was a large palpable iliac abscess and pulmonary tuberculosis. The first and second lumbar vertebrae were atrophied with blurred trabecular structure. The intervertebral disc is absent. Cheesy necrosis and wasting were noted in the lower half of the third lumbar vertebra in the upper middle part of which the nucleus is visible.

Fig. 5 L. M. 15 days after operation, which was performed in the presence of Dr. Albee of New York. The arrow marks the presence of a tunnel in the body of the third lumbar vertebra. This tunnel was made by the perforator which was inserted exactly to penetrate the nucleus of post allergic focal infection; the tunnel was bunged

with a little autobone graft as a hemostatic measure. There has been partial reabsorption of the caseous portions and the bony structures of the vertebra are well defined. Recalcification of the spinal column is noted as well as the presence of cortex and trabeculae.

Fig. 6 L. M. 8 months after operation. There is marked recalcification of the cortex and trabeculae. Cicatrization of the third lumbar vertebra is plainly visible and there is a tendency to fibrosis. The retraction of the scar pushes the third lumbar on the fourth due to the absence of the intervertebral disc. We do not apply casts and do not immobilize patients except when the cicatricial retraction is so great that marked kyphosis may result. The pulmonary tuberculosis is healed.

time to the study and observation of this focal point in roentgenograms. Interpretation has been made easier recently by the rapid advance and improvement in roentgen ray technique. This special focal point, this nucleus of post allergic focal infection, appears to us as a star shaped scar or agglomeration of tiny spots, the size of pin heads or small grains of rice. Here and there, however, the spots are always sharply outlined and resemble small metallic foreign bodies with rough edges and arranged often in the form of the spokes of a wheel. They usually are arranged in the form of an arc with three or four of the radii of the circle at equal intervals but the circle is not completed in the film.

If the peripheral or outside zones of the area supposed to contain or containing this nucleus of post allergic focal infection are

lightened with a solution of red aniline dye the common procedure in 'overcontrast' photographs, it is possible to obtain in prints of films a true picture of the nucleus with the characteristics noted.

We have sent to several hundred professors and to a total of 148 libraries of medical colleges of different states and countries films by which the characteristics of the nucleus of post allergic focal infection could be recognized.

In his book regarding local immunization¹ Besredka accepts Bichat's theory that there exist in each organ clusters of cells having the special ability to react not only anatomically but as well in their physiological functions. Thus Besredka and others have stated



Fig 7, left G L, Pott's disease (This was Case 75 of "My first 100 cases of Pott's disease reported in La Semana Medica, No 26, 1931.) The caseous necrosis and the destruction of 4 vertebrae, before operation. The intervertebral discs are absent. Patient was operated upon by perforating the first lumbar vertebral body. Patient was discharged a month later, walking without cast or support of any kind.

Fig 8 G L, 10 years after operation. The vertebrae formerly riddled with caseous necrosis, have now become transformed into a solid bone, rigid block. Patient is in very good condition, has no pains or contractions, and is fit for military service.

that certain cellular groups are susceptible to infection but become immunized even though the whole body responds, that is to say a tissue immunization exists. Confirming this theory of the elective tendency of certain cells against certain forms of infection of various virulence, we emphasize that we find that only one nucleus of post allergic focal infection exists in each case of osteo-arthritis, notwithstanding the fact that it may be formed by the combination of several diseased continuous bones. In coxalgia, for example, the nucleus, very large, is very often located below and to the inside of the antero-inferior iliac spine. In Pott's disease, the nucleus is very large and is located in the vertebral body near the point of implantation of both articular pedicle, often in the decalcified vertebra above or below the caseous necrotic focus. In doubtful case, it must have perforated two vertebrae. In knee it is small and very difficult to see.

We have presented here a process in which the body overcomes the local infection and exhibits a remarkable tendency, by virtue of large amounts of collagenous substance, to weaken the organisms which have established themselves and, by symbiosis, have begun to multiply. These bacilli do not reach the stage whereby they change the condition of tissue in which they are located because the body lessens their virulence. Furthermore, as has been accepted by many, there is formed in all "focal infections," a biological block that does not permit to pass the haptins, globulins (Landsteiner) or antibodies that in this instance are about to form autovaccines but allows to go through only the lysins (Maurice Nicolle), the poisons, which are more fluid, amino-acids. We maintain, then, that if there is an advantage locally, the system may suffer unless it is possible to free these imprisoned elements, elements capable



Fig 9



Fig 10



Fig 11

Fig 9 F V before operation Coxalgia. (This is Case 63 of the statistics presented at the Congress of Rosario 1934.) The roentgenogram discloses an enormous abscess clearly visible by opaque substances. Local heat, pain, edematous infiltration and adenitis were noted. The bone was so atrophied that it was almost transparent. The neck and head of the femur and articulating surface of the iliac bone and the cortex of the femur were considerably thinned.

Fig 10 F V 1 month after operation. A bone graft had been inserted making a tunnel in the neck and head of the femur and another one in the inside of the antero-

inferior iliac spine. The abscess was completely opened in the operation but closed later by primary intention. The pain has diminished and there is a decided improvement in the local and general condition. The iliac and femoral bones have become recalcified and are now more distinct. Patient discharged 4 months after operation, walking without cases of support.

Fig 11 F V 6 years later. Patient maintains his good general health. He has led an active life since discharge. Ankylosis is shown in the roentgenogram as well as marked recalcification and thickening of the cortex. There are visible beautifully marked lines of resistance in the femur

of forming autovaccines. Our experiences confirm the view of those among whom is professor Julio Mendes of Argentina, who believe that tuberculosis is principally a "focal infection." From such a focus lysins pass forth and, by greatly diminishing the defenses of the body, facilitate the caseous transformation of the new Koch bacilli localizations. For this reason I strive with my procedure to liberate the haptens for, when a nucleus of post allergic focal infection is perforated, it results in helping to reestablish the health of the patient, rapid detoxication and a tendency toward cicatrization of the existing lesions preceded by reabsorption of caseous material are noted and become more pronounced in the months following this comparatively simple operation.

The explanation of these phenomena is easy. The status of the nucleus of post allergic focal infection is changed completely by its perforation immediately the blood rushes in, the microbes suffer by the rude change in their culture medium, oxygen is rapidly

brought in and since oxygen does not favor the growth of tubercle bacilli they become weakened. The weakened bacilli, besides being easily affected by the lipolytic and proteolytic ferments, oxidases, etc., produce above all, weak antigens, namely autovaccines.

Since the patient carries these foci within himself—production centers of autovaccines—this action becomes continuous and prolonged, eventually diminishing the thickness of the new caseous masses. Meanwhile, nourished by the newly formed blood vessels, this material is transformed into whole lumps and, finally, into sclerosed, fibrous cicatricial masses.

Serological study shows that the Besredka and Vernes reactions are accentuated after the operation but frequently become negative in the following months when, clinically and roentgenographically, the patient is cured. In the days following puncture of the focus, the cutaneous reaction with von Pirquet's tuberculin becomes so marked that it generally takes the papular form, and sometimes

is hemorrhagic with extensive lymphangitis

A bacteriological and histological study of a tuberculous knee, operated upon by us 10 years previously, was made by Dr Vivoli, chief of the laboratory of the Hospital de Enfermedades Infecciosas, and Dr. Llambias, professor of pathological anatomy of the Faculty of Medicine of Buenos Aires. They both demonstrated the total absence of both the Koch bacillus and caseous material in the areas formerly carious but now refilled with compact, sclerosed cicatrices. In other words there was total elimination of the Koch bacillus; therefore the tuberculous infection had been cured.

It is generally admitted today that every tuberculous lesion, regardless of where it is located in the body, originated in the lung, or that tuberculosis was at one time manifest there.

The nucleus which is found in the lung, the nucleus of post allergic focal infection, is similar in every respect to that which we see in bone tuberculosis. In the lungs the nucleus is visible in well taken stereoscopic roentgenograms but only one is found for the two lungs, an observation which leads me to believe that it is a nucleus of post allergic focal infection. Quickly upon perforation of the nucleus detoxication begins and just as quickly or even more rapidly there follows in the succeeding months a transformation of the tuberculous caseation process into a fibrous and finally a cicatricial sclerosis. At the same time modifications of equal intensity occur in other tuberculous lesions of the body wherever located—in the joints, larynx, or even the intestines—regardless of how far away the perforated nucleus may be.

The operative technique is very simple once the nucleus of post allergic focal infection is visualized in stereoscopic roentgenograms, precise information is at hand as to the depth of the focus and we can then perforate the focus by the simple implantation of a bone autograft into the focus. The nucleus, which is always subcortical, may also be perforated by means of a trocar which may carry in the eye of its plunger various strands of catgut of different absorption dates, which may be left to fill the tunnel made by the needle in

the lung parenchyma. Catgut is not indispensable; the puncture tunnel in the lung is innocuous out of the hilum¹ and cheesy necrotic focus. These steps are sufficient to start the process of cure, in a few or many months, according to the extension and severity of the infection and the soil in which these lesions develop.

The reading of x-ray films to locate the nucleus of post allergic focal infection to operate upon is, and always will be, the essential and most vital point in this method of treating tuberculosis. Infinite care must be used and many stereoscopic roentgenograms must be made daily. Considerable practice in interpreting the roentgenograms is necessary to recognize in a shadow the outline of the scar and to determine its depth and location for guides in the perforation.

At first we were not as successful as we are at present. Our present figure is 76 per cent successful and we hope to better that even though we will use the method in grave cases. We used the method in Pott's disease 11 years² ago and we also have patients cured after the implantation of grafts in the lung 9 years ago. We can say, therefore, that our procedure has stood the test of time.

At our request the Faculty of Medicine of Buenos Aires appointed 8 professors, with the dean as president, as a committee to supervise operations and to study the results obtained, and after 6 months of work they made the following report:

Professor Robertson Lavalle's treatment of tuberculosis is simple and innocuous. In the patients whose progress we have followed after the operation, we have observed truly surprising results. We have examined patients operated upon previous to our appointment and their condition has remained satisfactory after application of this treatment.

(Signed) Professors José Arce (Dean), José A. Saralegui, Carlos Fonso Gandolfo, Raúl Arganaraz, Antonio R. Zambrini, Ludovico Facio, Enrique Castano, Ricardo E. Donovan.

After this report the University has in view creating a special institute where our method may be given a wider application.

¹Bull. et mém. Soc. nat. d. chir., 1917, 43, 103.
²Semana méd., 1931, No. 26.

THROMBOPHLEBITIS OF THE APPENDICIAL VEIN COMPLICATING ACUTE APPENDICITIS

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APPENDICITIS is a disease of civilized peoples. Wherever it occurs, the mortality is high. Statistics for the United States show that the number of deaths from appendicitis is more than one half of that due to automobile accidents (21). In spite of many years' experience, it seems that there still are factors in treatment that can be bettered. One of the factors which contributes to the high rate of mortality is failure, in a certain group of cases, to recognize the presence of thrombophlebitis of the appendicular vein. The occurrence of this complication so alters the diagnostic, pathological, prognostic, and therapeutic features, that there may be justification for placing appendicitis, thus complicated, in a category of its own.

In this paper a survey of this type of appendicitis will be attempted together with the operative treatment thus far practiced. A composite picture of the clinical history of suspected thrombophlebitis of the appendicular vein will be given and an operative procedure will be suggested by means of which the process may be localized. Finally, a series of illustrative cases which have occurred in the last 10 years will be cited. These cases were drawn from several Newark (N. J.) hospitals and will serve to show the complete picture in specific instances.

PATHOLOGICAL CONCEPTION OF THROMBOPHLEBITIS COMPLICATING APPENDICITIS

The formation of a clot in a vein is most frequently a protective reaction against the spread of an infectious agent which reaches its radicles. The infected clot is formed in the lumen of the vein in an attempt to prevent immediate regional spread of infection or the later development of infection of the blood stream. If the virulence of the micro-organ-

isms is such as to cause progressive enlargement of the thrombus in the general direction of the heart, the result is the formation of an infected clot in a larger vein. Small pieces of such a clot may become detached and, in this way, an infected embolus is set free in the venous blood, the point where the embolus lodges depends upon where it was formed. Thus, in infections involving the intestines the liver receives the embolus by way of the portal vein, while an infected embolus arising in the head or extremities is filtered out by the lungs. When such an embolus comes to rest it causes a local tissue reaction which, in turn, is manifested clinically, by a sudden rise of temperature and a chill.

The micro-organisms against which the body has the poorest protective mechanism are certain types of streptococci. They seem easily to penetrate local protective barriers and quickly gain entrance into the venous radicles. A chill may occur as a complication of any infective disease process, but more especially those caused by streptococci. For example, in acute mastoiditis a chill and rise in temperature indicate that the infection has spread to the lateral sinus, resulting in a thrombus. In order to forestall later emboli, surgeons ligate the jugular vein on the corresponding side.

A similar process is found in certain cases of acute appendicitis in which micro-organisms reach the venous blood stream and thrombophlebitis of the appendicular vein results. Such a condition is usually due to a rapid gangrenous process caused by infections in which the streptococcus predominates. The micro-organism probably causes gangrene by an overwhelming infection and by affecting the veins of the appendix. Once the venules are involved, a protective barrier against further spread is established by the formation of an infected thrombus which stops the venous drainage of the part and hastens gangrene (17).

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Whatever the mechanism may be which produces the thrombus, it does form in certain acutely inflamed appendices where there is rapid death of the part and in which the infection quickly reaches the venous radicles provoking the formation of a protective thrombus. Should a small portion of this clot break off, it is apt to lodge in the liver. In these circumstances a chill sets in, and a liver abscess eventually follows. No doubt there are many cases of acute appendicitis with septic thrombi in the appendicial vein that are unsuspected, and in which ligation of the mesentery during the removal of the appendix localizes the thrombus.

In a certain number of cases, however, a telltale pre-operative or postoperative chill gives warning of an existing thrombus and points to further procedures which should be attempted in order to stop any further septic emboli from being thrown off. Should the process progress unhindered, it may take one of two forms. More emboli may reach the liver, causing localized multiple septic areas and leaving the portal system comparatively free except for the small radicles about the appendix from which the trouble started. Or there may be marked inflammation of parts of the portal system, pylephlebitis, with massive purulent thrombi involving the ileocolic and right colic veins and liver involvement as well. Much of the literature on this subject deals with such cases or cases encountered at necropsy.

The first description of a case of appendicitis followed by pylephlebitis and liver abscesses is attributed by Loisson to Waller in 1846. Other occasional reports occurred sporadically over the next half century. Such articles were based entirely on the description of necropsy findings. In 1900, however, Deaver wrote, "The pylephlebitis is sometimes of the mild or non-infectious variety; frequently, however, the process is infectious, the thrombus becomes purulent, and leads first to abscess of the liver and subsequently to general infection with pyemia." He cites the cases of several patients who developed liver abscesses and in each of whom there was a history of repeated chills. Later he stated, "Chills are a rather uncommon occurrence in

appendicitis, yet if at the onset of the attack they occur in rapid succession, and are accompanied by temperature, they indicate a rapidly developing gangrene of the appendix. Chills occurring on the second or third day of the attack and associated with high fever usually indicate the development of metastatic or embolic abscesses." Kelly, writing 5 years later said: "Chills are exceptional in cases of simple diffuse inflammation, but are not rare with severe lesions. Of the patients with acute appendicitis not associated with abscess or general peritonitis admitted to Johns Hopkins hospitals, 15 per cent of them gave a history of chills, and in all of these, with the exception of two, the appendix was gangrenous, perforated, or distended with pus. Repeated chills occurring later in the course of the malady generally indicate a dissemination of the pyemic process." Thirty years ago, it would appear that these surgeons had practically recognized the disease entity of which we speak. They associated the condition with a gangrenous appendix in which dissemination of the purulent process into the portal system had taken place.

Individual case reports of liver abscesses following acute appendicitis and complicated by chills were cited by Bletchly, Bidwell, Brogden, and Cantab. Gerster, in 1903, suggested opening and draining the portal vein when it was found to contain a septic thrombus secondary to acute appendicitis. This procedure was the first operative interference to be suggested. It proved to be impracticable, however, because if the process extends this far, death is inevitable. Wilms, in 1909, cited the first case successfully treated by ligation of the venous radicles of the portal system. He stated, "On the second day a severe chill with high temperature occurred; three chills took place on the third day, and one on the fourth. Two hours after the last chill a second operation was performed. Upon exposure of the ileocecal region, the finger was introduced behind the ascending colon, thus freeing the beginning of the large intestines and the end of the ileum from the posterior parietes. After division of the posterior leaf of the mesentery into an oblique line between the ascending colon and the lower ileum, the



Fig 1 Bacteria in appendiceal vein thrombus (Gram-Weigert stain $\times 1200$ —Thalhimer)



Fig 2 Thrombus in vein of mesentery. The thrombus is lamellated in one place and purulent elsewhere (Hematoxylin and eosin stain $\times 250$ —Thalhimer)

vessels could be recognized. Two small arteries which were particularly prominent were isolated, to guard against their being included in the subsequent ligation. Two mass ligatures sufficed to tie off all the veins in this locality. No subsequent chill occurred. The patient made a smooth and uneventful recovery." Sprengel, in 1911, reported a similar case in which a gangrenous appendix was removed and chills developed on the eighth day after operation. With Wilms' success in mind, secondary ligation was attempted 4 days later, after two more chills had occurred. This operation was technically more difficult because a localized adhesive peritonitis was found binding the ileocecal region to the retroperitoneal tissues; ligation, however, was finally accomplished. The patient died 3 weeks after the second operation, having had frequent rigors in the interval. Necropsy revealed, in addition to a localized focus of infection in the right iliac fossa, pyelephlebitis of the superior and inferior mesenteric veins. The liver contained multiple abscesses of varying sizes. In the 1911 volume of *Progressive Medicine* (25) this statement occurs: "Pylephlebitis occurring as a sequel of appendicitis has attracted attention for the past 20 years or more. For

tunately, its occurrence in the vast number of acute inflammations is rare. The mortality is very high. Symptoms pointing to its presence usually begin some time after operation, generally during the second or third week.

The outlook for cure of this condition by operation is, naturally, not brilliant for by the time that the first chill and high temperature indicate the presence of this condition the entire portal system may be hopelessly involved. Nevertheless in so hopeless a condition it seems fair to afford a patient the chance that operation offers for even if only a majority of the infecting thrombi can be disposed of it is conceivable that the system may be sufficiently relieved thereby to cope successfully with the remainder.

Braun, following Wilms' technique, tried ligation of the ileocolic vein unsuccessfully. Later, in 1913, he reported two successful cases. Neuhof experimented on dogs by ligating the portal vein, having in mind its possible application in the treatment of suppurative pyelephlebitis. He found that complete ligation is immediately fatal, and advocated ligation of individual branches at different times to allow a collateral circulation to form. He

concluded that, in view of the inevitable fatality of suppurative pylephlebitis, such a radical procedure should nevertheless be attempted and if done in steps the ligation would not kill the patient. Eight years later Christopher recorded the case of a patient in whom the symptoms and signs simulated lung abscess as indicated by chills, sweating, and general prostration apparently arising from changes within the chest; there were no localizing abdominal symptoms. After unsuccessful attempts at treatment of the suspected lesion in the chest, death occurred, and necropsy revealed multiple abscesses in the liver arising as a result of a retrocecal gangrenous appendix with pylephlebitis.

In 1924 Thalhimer reviewed the subject and reported 4 cases which he had observed. His paper, although of great importance, has received scant attention. He attempted to show that this grave clinical entity is overlooked by many surgeons. He drew a complete picture of the condition and laid particular emphasis on pre-operative chills as important in selecting operative procedures to check the spread of pylephlebitis. He advocated inspection of the veins leading away from any necrotic appendix, and, if any thrombi were found, ligation of the veins above the thrombus at the ileocecal junction and around the caput coli. In 1926 Colp (10) again drew attention to the subject and cited 3 cases in which patients were treated by high ligation of the portal or superior mesenteric veins. He concluded that high portal ligation was of no avail as the condition, if it had progressed that far, was hopeless. It is interesting to note that all of these patients survived the immediate effects of the portal interruption, but finally died as a result of liver abscesses.

INCIDENCE

Colp (11), in analyzing 2,841 cases of acute appendicitis, noted a chill as a symptom before operation in 68 per cent of all cases. Kelly and Hurdon found a history of chills in 15 per cent of cases. Fitz, in 1886, tabulated his necropsy findings in patients dead of acute appendicitis and found pylephlebitis in 11 cases of a total of 257 (4.7 per cent). Armstrong, in 1897, found a necropsy incidence of

5 per cent in 546 examinations. Gerster, however, found only 9 such cases with pylephlebitis occurring in 1,187 cases of acute appendicitis. Braun (3) reported 8 cases in 600 patients; Moschowitz, 7 cases in 1,529 patients; Gatch and Durman, 1 case in 262 patients, and Giertz 4 cases in 533 patients suffering from acute appendicitis. Petern, in a series of 1,340 necropsies in subjects dead of acute appendicitis, found liver abscesses in 5 per cent. In a recent study of 1,463 consecutive cases of all types of appendicitis, covering a 10 year period at the Newark City Hospital, there were 12 cases with 4 deaths. Other later statistics also show a lower incidence. This is due to earlier operative interference in acute appendicitis. With careful questioning, however, more patients with pre-operative chills will probably be found who never go into the later stages because the appendix with the thrombus is removed early.

PATHOLOGY

This type of fulminating appendicitis is attributed to the streptococcus. Thalhimer shows several pictures of bacteria in a vein thrombus (Figs. 1, 2) but he does not report any cultural studies to determine what type of micro-organism was present. The appendix is either acutely inflamed or gangrenous with a friable mesenteriolium in which the veins are thrombosed. Bier cites a case in which he found streptococci in the portal vein while the appendix showed but little inflammation. In the cases cited in this paper, however, the pathological changes in the appendix were advanced in every instance. If the septic thrombus is not removed or isolated when the appendix is removed, the thrombus extends upward. Sooner or later a small septic embolus may break off and, passing by way of the portal system, lodge in the liver, leaving the portal vein and most of its tributaries free. Thus, the ileocolic vein may be explored and found to bleed freely, containing no thrombus. Nevertheless, the radicles of the same vein may contain infected thrombi distal to the point of inspection and they may continue to be discharged into the liver unless the vein is ligated (Case 9). At times there may be a massive thrombus in the portal

system extending almost to the liver. In such a case, along the course of the vein, small localized abscesses may be formed due to perivenous infection. Until the liver is riddled with abscesses and its venous drainage has become thrombosed, the general systemic circulation may remain free of bacteria. Positive blood cultures are rare, as are lung abscesses secondary to liver abscesses. Empyema of the right chest by direct extension from a liver abscess is more common. There are some cases of jaundice due to liver destruction. Often a subicteric tinge is present. This change usually occurs later in the progress of this disease.

Another possible course for the infection to travel is through the lymph channels that lead to the liver, diaphragm, and subhepatic spaces. This avenue is probably more important in producing perihepatic and subdiaphragmatic abscesses. Most investigators, however, place little stress on the part played by the lymphatic channels or do not consider them at all.

Changes in the peritoneum vary with the stage of infection. In an advanced case of pyelephlebitis with massive clotting in the portal system there is usually an adhesive inflammatory process with edema of retroperitoneal tissues and regional lymph nodes. In other equally severe cases, on the contrary, the peritoneum may appear to be only slightly involved.

Sonnenburg believes that in all acutely inflamed appendices there are thrombosed venous radicles but that the virulence of the infecting micro-organisms is not sufficient to overcome local resistance and the affected radicles are removed early enough in most cases to preclude further development.

SYMPTOMATOLOGY

The patient usually gives a clinical history indicative of acute appendicitis. However, in addition, careful questioning is apt to elicit history of a chill which may have seemed so unimportant to the patient as to pass unnoticed. Even when a chill has occurred, the patient often attributes it to some condition other than that of his immediate illness. The thermal reaction of the body is similar to that

caused by the streptococcus elsewhere. Usually, even at the outset, the high elevation of the temperature is in strong contradistinction to that of other types of acute appendicitis in which severe local disease of the appendix may cause less than a degree of fever. Another important clinical observation is that these patients, as a rule, are more severely prostrated than in the usual type of acute appendicitis.

DIFFERENTIAL DIAGNOSIS

The most common condition to be confused with this disease is kidney infection or ureteral block on the right side. In this latter condition a chill may occur, but while the kidney region, or right flank, may be tender, the signs of acute intra abdominal inflammation are absent. Suspicion of early pneumonia with chill, prostration, and occasionally reflex abdominal muscle spasm may be entertained, and the diagnosis between the two may be difficult, although in acute appendicitis the lower right quadrant signs are usually easily detected early in the disease. If the patient is seen late the picture may be confusing because some of the signs may then have shifted to the upper right quadrant. In such circumstances liver or gall bladder disease or a subdiaphragmatic or liver abscess of different etiology may have to be excluded. Other possible confusing conditions that should be mentioned are right sided pelvic inflammatory disease, acute gastro-intestinal disturbances with chills, and early deep phlebitis of the right lower extremity.

In spite of the foregoing evidence accumulated over a period of years, some clinicians still believe that a chill associated with symptoms suggestive of appendicitis does not point to appendiceal inflammation with thrombus formation and secondary embolism. Some still deny that such an entity exists and attempt to explain the sequence of events by some process other than that of acute appendicitis. It has even been said that a chill excludes the diagnosis of appendicitis. The burden of proof rests on the exclusion of acute appendicitis. It is important to emphasize this point so that the diagnosis may be made early. If there is delay if only for a few hours,

the damage may have become irreparable, especially, if, in the interim, septic emboli have lodged in the liver. It is possible that the liver can overcome a small dose of infected material, but a large dose is almost certain ultimately to cause death in spite of all therapeutic measures.

SURGICAL TREATMENT

Operation is best performed at the earliest possible moment. Spinal anesthesia is the anesthetic of choice, if the patient's condition will allow its use. With this type of anesthetic the viscera are quiet and the abdominal muscles relaxed, permitting a maximum of exploratory possibilities. The right rectus incision with the upper end opposite the umbilicus seems the incision of choice as giving the maximum exposure for exploration. By placing the patient slightly on the left side with a sandbag under the right loin the intestines tend to fall away from the right gutter. After the abdomen is opened the small intestines are packed away with hot sponges to obtain a clear view of the ileocecal junction. The small tributaries of the ileocecal vein may be seen beginning to form a common trunk which runs in the posterior parietal peritoneum in a line drawn from the ileocecal valve to a point in the midline midway between the umbilicus and the xiphoid process. The vein does not continue the whole length of this imaginary line as it empties into the right colic vein just above the umbilicus. It will be found to join the right colic vein just below the third portion of the duodenum. Care should be taken, if there be any question as to anatomical location, to identify this point of juncture and to interrupt the venous return distal to this point, i.e., to ligate the ileocolic vein only. Lying to its medial side throughout its course is the ileocolic artery. The vein thus identified is gently palpated for the presence of a thrombus which, if present, stands out as a stiff, cord-like structure. An attempt is made to follow the vein above the thrombus to a point where the vein has no clot in its lumen. Even though no thrombus be found, the vein should be isolated, ligated, and then severed, the point of ligation being as close to the right colic vein as possible. Walcker (Fig. 3) has

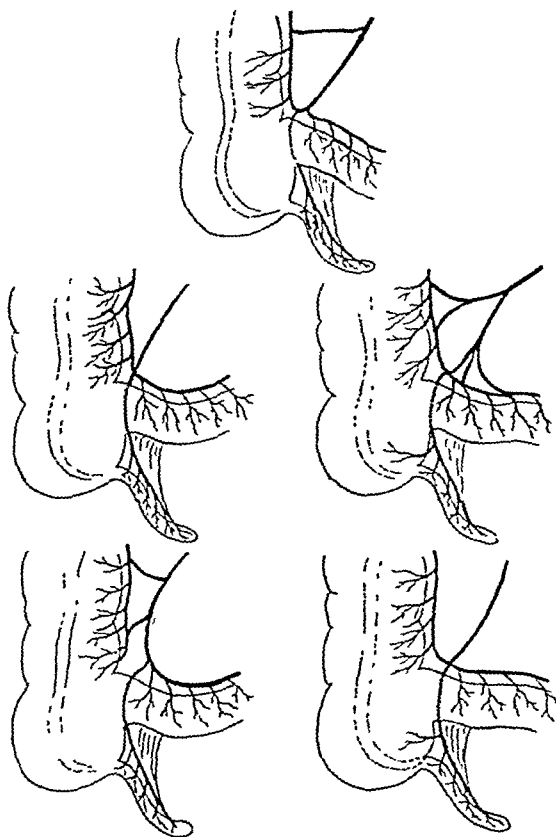


Fig. 3. Anomalies of the venous drainage of the ileocecal angle (From Walcker, loc cit)

pointed out the anomalies of the veins draining the ileocecal region. With these anomalies in mind, a low ligation of the ileocolic vein might fail to prevent further spread of the process into the liver. However, ligation of the ileocolic vein just before it empties into the right colic vein will avoid not including the whole venous drainage of this area even though it should be anomalous. This point of ligation is about 4 inches in the above mentioned line from the ileocecal valve. There is no fear of causing gangrene of the intestine by this procedure. In a certain number of cases the circulation is already obstructed by the thrombus in these veins, and in no case has gangrene been observed. Colp (10) cites several cases of ligation of the portal vein itself without ensuing gangrene. This part of the operation should be performed before the appendix is removed.

At times the process may be so early as to make opening the retroperitoneal space unnecessary. When the thrombus is limited to one small nodule the appendiceal vein may be dissected high behind the ileocecal junction and ligated at this point. Such a procedure has been done in certain cases in which there was no chill, but in which the appendiceal veins were found thrombosed at operation. It was also done in several other early cases in this series in which a chill had occurred but the thrombus was found only in the appendiceal veins. In the late case with several pre operative chills such an operation is usually insufficient and only leads to trouble later as the process has advanced beyond the point of attack.

REPORT OF CASES

Twenty four cases are here presented. For the purpose of accuracy they have been divided into a proved and a presumptive group, although they are all thought to be illustrative of the disease entity under discussion. In these 24 cases the history, presence of a chill or chills, together with definite operative findings of acute appendicitis, all fit into one similar clinical picture. Only proved examples of thrombophlebitis are included in the group to be listed first. In the presumptive group have been listed those cases in which either no thrombus was found or noted in the operative record and those cases in which a thrombus could not be identified because of existing pathology. In several of these cases no autopsy could be obtained to prove the diagnosis.

PROVED CASES

CASE 1. E. S. admitted to Newark City Hospital January 28, 1930, white male, 32 years old with history of dull continuous pain in the right lower quadrant for the past 2 weeks. Patient had several acute exacerbations of pain. He vomited once about a week ago. Pain has been more severe in the past few days. He has had chilly sensations on several occasions. Temperature on admission was 100.4 degrees, pulse 100, respirations 22. Examination revealed extreme tenderness in the right lower quadrant. Patient did not look extremely ill. Patient was operated upon 2 hours after admission. The abdomen was opened through a McBurney incision. The appendix was gangrenous throughout the mesenteric vein was thrombosed. The meso-

appendix was ligated high and the stump was inverted. Two roll rubber drains were inserted through a stab wound. Patient's course was without note except for an acute bronchitis. He left the hospital on the twentieth day.

CASE 2. C. G., admitted to Presbyterian Hospital December 31, 1930, a 15 year old schoolgirl gave a history of abdominal pain for past 3 weeks. Chills, high fever, increase in temperature and pain in right lower quadrant, nausea and vomiting. An icteric tinge to the sclera was noted. High color to urine. She was brought to the hospital for observation and diagnosis. Temperature on admission 105.0 degrees, pulse 130, respirations 34. Blood count 20,000 with 86 per cent polymorphonuclears. Patient on admission was toxic, somewhat dehydrated. Examination showed moderate tenderness in right lower quadrant with suggestion of a mass the size of an egg and marked rigidity in right upper quadrant with some tenderness over the liver. Operation was performed January 1, one day after admission with pre operative diagnosis of retrocecal appendiceal abscess with pyelphlebitis. The abdomen was opened through a McBurney incision. A large mass was found surrounding the appendix. The appendix was removed. Two roll rubber drains were placed in the area of the appendix, one Penrose drain in pelvis. The wound was closed in layers. Temperature remained high. On first postoperative day she had a chill followed by one or more chills on the second, third, fourth, fifth, ninth, eleventh, thirteenth, seventeenth, and eighteenth days. Temperature was spiking in character and hectic. Patient was transfused on the ninth day after operation. She continued to complain of pain in the right upper quadrant. In spite of supportive measures and intravenous fluids course continued downhill with vomiting and abdominal distention. Death occurred on the twenty second day after operation. Autopsy revealed acute spreading peritonitis secondary to a gangrenous appendix, pyelphlebitis of mesenteric and portal vessels, multiple liver abscesses, toxic nephritis and myocarditis and terminal pulmonary edema.

CASE 3. L. R. admitted to Newark City Hospital October 4, 1931, white male, 28 years old, complaining of cramps and pain in the stomach and in the lower left quadrant for 2 days. Day before admission he took castor oil. On day of admission he had a chill and a high fever. On admission his temperature was 104.3 degrees, pulse 88, respirations 22. Operation was performed 1 hour after admission through a right rectus incision. The abdomen showed rigidity in both quadrants with deep and rebound tenderness. No masses were palpable. Rectal examination revealed a mass high just to the right of the midline. It was a curving putty like mass the size of a pencil. It was tender. Diagnosis was made of acute gangrenous appendicitis with pyelphlebitis. The peritoneum was opened and revealed free red tinged milky fluid. The appendix was found black and ruptured dipping over the brim of the

pelvis, with thrombosis of the appendicular vessels. The appendix was removed. A thrombosed mesentery was dissected out high above thrombus. Two rolled rubber drains were inserted through a stab wound. Sliver drains under fascia. Patient made a good and uneventful postoperative recovery except for superficial wound infection. He was discharged from the hospital on the twenty-fifth day after operation.

CASE 4. H. H., admitted to the Presbyterian Hospital December 30, 1931, white male, 13 years old; with a history of pain in the stomach for 1 day followed by vomiting and localization of the pain around the umbilicus. He had had one previous attack 2 months ago. Diagnosis of appendicitis was at first ruled out, but in 24 hours the symptoms again recurred and the patient was admitted to the hospital. Ice cap was placed on the abdomen and patient was kept on liquids. On the first day after admission the patient had a severe shaking chill lasting 20 minutes. A consultation was called and an immediate operation was then decided upon. White blood count before operation was 11,500 with 88 per cent polymorphonuclears. A diagnosis of acute gangrenous appendicitis with thrombophlebitis was made. Operation was performed through a lower right rectus incision. Appendix was kinked at its mid-point, the distal half being gangrenous. There was a definite thrombophlebitis of the appendicular vein. Appendicular vein was ligated high above the thrombus, and the appendix was removed in the usual manner. The stump was buried. One Penrose drain was brought through a stab wound. The wound was closed in layers. Patient's course was not stormy. Temperature gradually fell. Large quantities of intravenous fluids were given for 5 days. On the twelfth day after operation there was an unexplained rise in temperature to 101° degrees. Patient, however, looked so well that he was discharged from the hospital 2 days later on the fourteenth day after operation.

CASE 5. R. B., admitted to Newark City Hospital January 8, 1933, white male, age 39 years; with a history of being well until the day of admission when he began to have pain around the umbilical region which was sharp and cramplike. It then descended to the right lower quadrant and he began to vomit. He began to feel feverish and came to the hospital, he had a real chattering chill which lasted for several minutes. On admission he had a temperature of 105° degrees, pulse, 120, respirations, 28. He complained of pain in the right lower quadrant and on examination he was found to have moderate rigidity and rebound tenderness over McBurney's area. No masses were palpable. Diagnosis of acute gangrenous appendicitis with thrombophlebitis of the appendicular vein was made. He was operated upon 4 hours after admission. His abdomen was opened through a right rectus incision. The appendix was found swollen, edematous, injected, and friable. The veins of the appendix were noted to be everywhere thrombosed. The appendicular vein was followed up the mesentery

until it could be ligated above the palpable thrombus. It was then cut and ligated at both ends. The appendix was removed in the usual manner. The stump was buried. The abdomen was closed in layers; no drainage. Patient's temperature dropped from 105° to 100° degrees within 12 hours. Temperature never again went above 100° degrees, and he made a successful recovery unhampered, to be discharged from the hospital on the tenth day after operation.

CASE 6. T. G., admitted to Presbyterian Hospital February 12, 1934; white male, 50 years of age; complained of onset on previous day of slight diarrhea and pain across lower abdomen, with a slight nausea and some vomiting. The pains persisted in the right lower quadrant. The preceding evening he had had several chills followed by a high temperature. He gave no history of previous attacks. Examination showed abdomen to be distended with gas, tenderness and spasticity in the right lower quadrant with rebound tenderness, but no masses. Temperature on admission was 102.6 degrees; pulse, 90. Leucocytes numbered 12,000 with 90 per cent polymorphonuclears. A diagnosis was made of gangrenous appendicitis with pylephlebitis. Operation was done 2 hours after admission through a right rectus incision. A gangrenous appendix with a thrombosed mesenteric vein was dissected high and the vein was ligated above the thrombus. Two Penrose drains were placed through stab wound, one into the pelvis and one into the right gutter. He was given intravenous fluids after operation. Temperature declined uneventfully. Patient made a smooth recovery. He was discharged on the twentieth day after operation.

CASE 7. E. B., admitted to St. James Hospital February 23, 1934, white male, 20 years old; complained of onset of pain across the lower abdomen 3 days previous. The pain was sharp and continuous. He vomited several times. Two days ago he was given a laxative and since then he has had diarrhea. Pain continued to be severe up to admission. He began to feel feverish the day of admission. Two days before admission he also had a shaking chill which lasted about 10 minutes. When admitted to the hospital his temperature was 102.6 degrees, pulse, 102, respirations, 24. He had tenderness and rigidity over the lower abdomen, more in the right lower quadrant. He complained of severe abdominal pain. The white blood count was 28,750 with 87 per cent polymorphonuclears. The urine showed 2 plus albumin. A diagnosis was made of acute gangrenous appendicitis with thrombosis of the appendicular vein. Operation was performed through a McBurney incision, revealing a small amount of clear serous fluid. The appendix, stiff and bound in adhesions from the omentum and the terminal ileum, lay at the pelvic brim. The adhesions were freed. When the mesoappendix was separated down to its base, a hard, bluish, tube-like structure which was the appendicular vein, thrombosed throughout, was found. The appendix was clamped, tied off, am-

puted and the stump was inverted. Because of the patient's condition the thrombosed appendiceal vein was not dissected up behind the ileocecal valve but a ligature was placed above the thrombus. No intra abdominal drainage was used. Silver drain was placed under the fascia. Patient had diarrhea for 1 week after operation. He was given large quantities of fluids. On the fourth day he had a severe shaking chill for 10 minutes and his temperature rose to 104.6 degrees. Temperature fell again, immediately after the chill. Temperature gradually returned to normal. On the twelfth day the diarrhea abated and the patient's condition seemed good except that he complained of abdominal pain daily. The temperature remained flat for 4 days more until the seventeenth day when he began to have a temperature rise with an increase of diarrhea. The abdomen was soft but he complained of abdominal pain. Blood count showed 31,250 leucocytes with 85 per cent polymorphonuclears. Stool examination for parasites was negative. He still had two plus albumin in the urine with a few pus cells. Diarrhea was not controlled by bismuth. However, after reaching a peak of 102.0 degrees on the twenty-second day temperature gradually fell to normal on the twenty-sixth day. From then on he continued to be free of fever and symptomless until his discharge from the hospital on the thirtieth day after operation.

CASE 8. F. A. admitted to Newark City Hospital June 5, 1934, white female aged 24 years, complained of onset of abdominal pain on the morning of the day before admission. There had been no attacks similar to the present condition. Onset of pain was followed by nausea and vomiting in several hours. Pain was of a sharp and intense character. It soon localized in the right lower quadrant. She had a chill and noticed that she had some fever. Pain then became of sharp character radiating to the upper right quadrant and accompanied by pain in the shoulder. She vomited several times the night before admission. She was thought to be about 8½ months pregnant. A provisional admission diagnosis was made of acute suppurative appendicitis complicating pregnancy. On physical examination she was found to be dehydrated and dyspneic with slight cyanosis. Temperature was 101.6 degrees, pulse, 131; respirations 40. The abdomen was found symmetrically enlarged, the uterus extending midway between the umbilicus and the xiphoid. Position of the child was determined as left occiput anterior. The child was alive with a strong regular heartbeat of 134 a minute. There was direct and rebound tenderness over the entire abdomen especially the right lower quadrant. Moderate rigidity was found all over the right side of the abdomen. White blood count was 17,400 with 88 per cent polymorphonuclears. A diagnosis of retrocecal gangrenous appendicitis with pyelephlebitis was made. She was given 1,000 cubic centimeters of saline solution before operation. Operation was done through a high McBurney incision. When the

peritoneal cavity was opened free purulent fluid with a strong *Bacillus coli* odor welled into the wound. The uterus which encroached on the medial side of the wound was walled off with a warm sponge. The cecum was found lying high out of the right lower quadrant just in the upper quadrant. The appendix was gangrenous, bound down and in a retrocecal position. A large fecolith was found lying free in the abdomen. An attempt to invert the stump was not entirely successful due to the position of the appendix. The appendiceal vein was ligated high above a thrombosed mesentery. Two Penrose drains were placed in the right gutter through a stab wound. Several silver drains were placed under the fascia. Because of the pregnancy a duodenal suction drainage as a prophylaxis against expected abdominal distention was started immediately. She was given fluids by vein and under the skin. General postoperative course was not so stormy as might have been expected. Distention was quite easily controlled. On the sixth day she showed slight vaginal spotting with no pain. This was the only sign of possible interruption of the pregnancy on this admission. The wound drained freely of thick foul *Bacillus coli* pus; the drainage gradually diminishing to a scant spotting at the time of her discharge from the hospital. She was allowed out of bed on the fourteenth day and was allowed to go home on the eighteenth day with the advice to go home and remain in bed. However, 2 days later she was admitted to the obstetrical ward in early hard labor. She was delivered 9 hours later of a living normal child. Following the delivery of the placenta there was a moderate quantity of foul smelling purulent material expressed from the vagina. A culture of this material and a direct smear both showed a gram positive diplococcus. The puerperium was uneventful except for a rise in temperature to 100.4 degrees on the third day. Blood Wassermann was negative. She again left the hospital on the tenth day postpartum.

CASE 9. D. D. admitted February 2, 1935 to Newark City Hospital, white male aged 30 years with a history of developing continuous sharp pain about the umbilicus on the day before admission with nausea and vomiting. The pain shifted to the right lower quadrant. There was no history of any previous attacks. On the day of admission patient had a severe shaking chill which lasted about 10 minutes. Temperature on admission was 100.4 degrees, pulse 100, respirations 26. He had direct and rebound tenderness over McBurney's point with some rigidity. White blood count was 13,200 with 89 per cent polymorphonuclears. Diagnosis was made of acute gangrenous appendicitis with thrombophlebitis and operation was performed 4 hours after admission. Because a mass was thought palpable in the right lower quadrant a McBurney incision was made revealing marked localized adhesive and purulent peritonitis surrounding a gangrenous appendix. Although pyelephlebitis had been suspected no extensive operation was performed be-

cause of fear of spreading the virulent process throughout the abdomen. The appendicial vein was, however, exposed as high as possible and ligated. One Penrose drain was placed through a stab wound. After operation he had a cough, productive of thick, tenacious mucus. It seemed to clear up within 3 or 4 days with medications. On the fifth day he had a slight chill with temperature of 104.2 degrees, and another on the tenth day. He was given large quantities of fluids by hypodermoclysis. He continued to vomit in spite of duodenal suction drainage through a Levine tube. His condition seemed poor. He began to cough and expectorate repeatedly. He vomited intermittently. There was but little drainage from the stab wound. The wound was healing well and seemed clean. This general picture continued until the third week when he seemed to be gradually improving. On the twentieth day after operation he had a severe shaking chill with a temperature elevation to 105.0 degrees. The next day he received a transfusion of 500 cubic centimeters of blood. He seemed much weaker. His vomiting and abdominal pain returned. He again had another chill 2 days later. Secondary exploratory operation was done on the twenty-fourth day through a long right rectus incision, revealing free, thin reddish fluid in the abdomen. No pocket of pus was encountered. All of the mesenteric glands were enlarged. The pancreas and liver were enlarged. On the dome of the right lobe of the liver, 3 hard nodules were palpable. The ileocolic vessels were explored and opened. They bled freely showing there was no massive thrombosis. Diagnosis was made of multiple liver abscesses. He received a transfusion the next day together with intravenous fluids. He continued to vomit. A Levine tube was again inserted. He received another transfusion on March second, and on the same day 6 hours after the transfusion he had another severe chill, followed by another one on the next day. Successive blood cultures taken at this time were negative. X-rays of the chest were negative until April 6, when the dome of the right diaphragm seemed raised. He had been having chills on and off every few days with few other signs in the abdomen except right upper quadrant tenderness. On April 9 he was taken to the operating room again and the twelfth rib resected in the midaxillary line in order to drain a subphrenic abscess and a contiguous liver abscess. Blood cultures remained negative throughout. He continued to have chills. His condition did not improve. He continued to appear weak and listless in spite of continued transfusions and other supportive measures. He vomited frequently. He went downhill gradually and on April 24, he died, 81 days after admission. At autopsy there was found a slight icteric tinge to the scleræ. Otherwise, the autopsy was essentially negative except for the abdomen. The lower part of the abdomen contained straw colored fluid. There was a purulent plastic exudate of the lower abdomen. There were fresh adhesions of the superior surface of the liver to the diaphragm.

Small amount of purulent fluid was found over the right lobe of the liver. There was extensive plugging of the portal vein at the hilus of the liver with a purulent organized thrombus. The left lobe of the liver was practically free of abscesses. The right lobe of the liver was riddled with discrete confluent abscesses which contained creamy, thick, yellow, foul pus.

CASE 10 L. B., admitted to Presbyterian Hospital June 2, 1935; white male, 39 years old; with a history of having chills and fever every night for the past week but no symptoms during the day. Patient went to work during the day, at night he felt chilly and had a chill. Several nights previous he vomited. He had had no pain to speak of since the beginning of his illness. On admission to the hospital he had a temperature of 101.4 degrees; pulse, 88; respirations, 22. White blood count was 10,000 with 80 per cent polymorphonuclears. On examination he did not seem acutely ill. He was slightly dehydrated. There was some tenderness in the right lower quadrant with moderated rigidity of the right rectus muscle. A kidney infection on the right side was considered as the probable diagnosis for the first 24 hours in the hospital because a urinary examination erroneously reported the presence of a large number of leucocytes. After this possibility was ruled out by subsequent urinary examinations, operation was decided upon to determine whether the pathology arose from the appendicial vein as was then suspected. Operation was done with spinal anesthesia through a right rectus incision 5 inches long. An appendix gangrenous at its tip was found. The mesentery of the appendix was edematous and contained hard, cord-like veins. Palpation of the ascending ileocolic leaf of the mesentery revealed an edematous, ecchymotic mass extending upward, which was identified as the ileocolic vein. The mesentery of the ascending colon was separated by blunt dissection and the ileocolic vein was ligated high, about 6 inches above the ileocecal valve. The appendix was removed, the stump inverted, and the abdomen was closed in layers. A silver drain was placed under fascia. At the time of operation his temperature was 104.0 degrees. Following the operation his temperature continued to be high. For 43 days he continued to have a spiking temperature going to 106.0 and 107.0 degrees following rapid and frequent chills which occurred sometimes twice a day. He received intravenous fluids and multiple small blood transfusions. The abdominal wound was well healed. His abdomen did not become distended. His chills later became more violent in character, some lasting as long as 55 minutes. He died 44 days after admission. Autopsy revealed the abdominal cavity to contain a considerable amount of clear fluid, about 4 liters. There were a large number of adhesions between the intestines and the gall bladder. In addition, there were pus pockets containing thick greenish pus on the right side of the abdomen. The mesentery contained a large amount of pus in areas extending along the mesen-

teric vessels. There were abscesses along the portal vein. The liver was enlarged, congested, and the left lobe was practically gone, being replaced by a large abscess containing thick green pus. The right lobe contained small abscesses scattered throughout, apparently along the veins. The spleen was tremendously enlarged, dark and soft.

CASE 11. W. B. admitted to Presbyterian Hospital August 23, 1935, white male 43 years old, complained of sudden pain in the epigastrium beginning the day of admission. Pain soon descended to the right lower quadrant. Nausea followed and had persisted to admission. About an hour before admission he had a chill. Examination on admission showed a well developed adult male apparently acutely ill and suffering pain in the lower abdomen. There was direct and rebound tenderness over McBurney's point. Temperature was 101.4 degrees pulse 96. A diagnosis of gangrenous appendicitis with pylephlebitis was made. Operation was done within 1 hour after admission through a lower right rectus incision. The appendix was brought into the wound. The mesoappendix was ligated high above a thrombosed appendicular vein. The appendix was removed in the usual manner, no intra abdominal drainage. Silver drain was inserted under the fascia. Patient was given intravenous fluids and sedatives. Postoperative course was uneventful. Was discharged on the twelfth day after operation.

CASE 12. C. M. admitted to Newark City Hospital October 13, 1935, colored male 32 years old, was placed on the medical service with a diagnosis of pyelitis. Past history was essentially negative. Present history states that he was out drinking 10 days ago and came home drunk. The next day while at work he had some slight abdominal pain which cleared up after an hour or so. He continued at his work. After leaving work he went to bed as he did not feel well. That night his doctor ordered salts and cream of tartar for the patient. Two days after the onset and soon after he took the cathartic the patient felt nauseated and vomited once. He has also vomited once since then. For the past 8 days he has been having chills about 2 a day. He has been feeling feverish all this week. He now has some pain and tenderness in the right upper quadrant. On admission his temperature was 103.0 degrees pulse 88 respirations 24. White blood count was 8,900 with 82 per cent polymorphonuclears. The urine showed a specific gravity of 1.022 with trace of albumin. Another specimen was positive for bile. The sclerae looked slightly jaundiced. The abdomen was distended but no masses were palpable. There was tenderness over the costal border in the right upper quadrant. Diagnosis while on the medical service was possible pyelitis, possible septicemia and possible typhoid fever. Two days after admission the white blood count had risen to 13,200 with 84 per cent polymorphonuclears. Four days after admission the medical service made a diagnosis of sub-diaphragmatic pleurisy with abscessed liver, the etiology being (1) mesenteric thrombosis (2) pyle-

phlebitis from acute appendicitis (3) ruptured gastric ulcer. A surgical consultation was called and a diagnosis made of pylephlebitis secondary to acute appendicitis. He was transferred to the surgical ward and on October 18, 5 days after admission was operated upon. The abdomen was opened through a right rectus incision. The peritoneal cavity contained a moderate amount of free straw colored fluid. There was a great deal of edema of the mesentery and the mesenteric glands were palpable. There was a mass consisting of appendix and omentum in the right lower quadrant. The appendix was retrocecal. It was removed with the cautery and the stump was inverted with a purse string. One inch from the base of the appendix along the ileocolic vessels there was an abscess cavity containing foul smelling pus. One inch proximal to this point and parallel with it was another abscess cavity. The ileocolic vein was ligated 3 inches from the appendix and ileocecal angle. No thrombus was found at this point. Two drains were placed through a stab wound into the right gutter and abscess cavities. The wound was closed in layers. Patient was given large amounts of fluids after operation. He continued to have severe chills and temperature shooting up to 105.0 degrees. He went steadily downhill, dying 2 days after operation and 1 week after admission to the hospital. Autopsy revealed multiple liver abscesses, suppurative abscesses along the course of the ileocolic and portal vein with thrombosis of the portal vein at its entrance to the liver. There was marked liver destruction by abscess formation.

CASE 13. W. S., admitted to Newark City Hospital October 26, 1935, 15 year old white male, assigned to the Surgical Service with complaint of abdominal pain which had started 2 days previously and which had begun with cramps around the umbilicus. Patient had vomited nine times since the onset. The pain shifted to the right lower quadrant. There had been loss of appetite and the bowels had become irregular. On day of admission in the morning he had a chill. The day the pain began he took a strong cathartic and an enema. Temperature on admission was 103.6 degrees pulse 120 respirations 20. A diagnosis was made of a ruptured appendix. The abdomen was rigid throughout with direct and rebound tenderness more in the right lower quadrant. Patient was operated upon 4 hours after admission through a McBurney incision. The peritoneum was opened and revealed pus in the abdomen. A ruptured gangrenous appendix was found covered with omentum and fibrin. A thrombus could be palpated in the appendicular mesentery. The appendicular vein was ligated high above the thrombus. The appendix was removed and the stump inverted. Two Penrose drains were placed through a stab wound. The abdomen was closed in layers with clips in the skin. The postoperative course was uneventful except for profuse purulent drainage from the wound, the temperature dropping to normal after the first week.

CASE 14. H. S., white male, aged 63 years, was admitted to the Presbyterian Hospital on January 7, 1936, with a history of having had an attack of lower right quadrant pain 4 days before admission. He was nauseated and vomited. Two days after it started he took a cathartic. For the past 2 days the pain has been more severe and has remained in the right side. He has been unable to eat. There is no history of a chill. On admission he had a temperature of 102.4 degrees, pulse, 80, respirations, 28. He was dehydrated, not in any apparent acute distress at present or complaining of severe pain in the right side. Examination was essentially negative except for the abdomen which was soft except in the right side where there was direct and rebound tenderness and also a small palpable mass in the right lower quadrant. A pre-operative diagnosis was made of acute appendicitis with thrombophlebitis. Operation was performed through a lower right rectus incision 1 hour after admission, and revealed a gangrenous appendix which was perforated at its base. The appendix was removed and the stump was not inverted. The abdomen contained thick purulent fluid which was aspirated. Two Penrose drains were inserted and brought out through a stab wound. The wound was closed in layers, leaving one sliver drain under the fascia. The patient apparently made an uneventful recovery for the first 17 days. The wound drained a great deal of thick pus. On the eighteenth day one Penrose drain was removed and approximately 12 hours later he had a severe, shaking chill. He was apparently comfortable and without complaint until the chill occurred. The temperature rose to 102.0 degrees. Patient vomited after the chill. He had another chill that evening lasting 30 minutes with a temperature of 103.0 degrees. On the twenty-third day after operation another Penrose drain was removed, it was followed in 7 hours by another severe chill lasting 20 minutes. He complained of feeling chilly the next day and the following day he had another severe chill. The next 6 days he had successive chills with temperature rises up to 105.0 degrees. On February 8, 32 days after his appendectomy, he was again operated upon and a ligation of the ileocolic vein about 4 inches above the ileocecal valve was performed through a right rectus incision opposite the umbilicus. Duration of the operation was 45 minutes. Exploration of the abdominal cavity was not done. The ileocolic vein on section bled freely. For 2 days after the vein ligation the patient's temperature remained normal. On the third day after this operation he had three severe chills and until the date of his death, 45 days after the original operation, he had at least one chill and high temperature rise each day. Blood cultures on several occasions showed a growth of non-hemolytic streptococci. Autopsy showed a liver with one large abscess and several small abscesses, along the course of the portal vein there were small abscesses with a large thrombus almost filling the portal vein. The area of ligation was explored and distal to the point of ligation the

small veins were found thrombosed, but the intestine in this area was not affected by this interruption of the blood supply. There were multiple small abscesses also in the lungs.

CASE 15. W. T., white male, age 43 years, was admitted to St. Mary's Hospital, Orange, June 28, 1936, with a history of having been awakened from his sleep early on the morning of admission with severe abdominal discomfort. The pain was relieved after defecation only to return in several hours. The pain remained generalized in the abdomen most of the day. Toward evening it centered in the right lower quadrant. Just previous to admission patient had a shaking chill followed by another after admission. On admission patient's temperature was 102.0 degrees, pulse, 98, respirations, 20. Physical examination was essentially negative except for a moderately rigid abdomen with considerable rebound tenderness. The pre-operative diagnosis was acute appendicitis with thrombophlebitis. He was operated upon 5 hours after admission, by Dr. A. J. Ganley, through a McBurney incision. A gangrenous appendix was found. No free abdominal fluid was present. The appendix was removed, the mesentery of the appendix was ligated high, and the abdomen was closed without drainage, one sliver drain being placed under the fascia. The temperature fell to 100.0 degrees on the first day after operation and remained normal after the fourth day. He made a completely uneventful recovery except for catarrhal conjunctivitis, to be discharged from the hospital on the eleventh day after operation. Microscopic pathological examination report reads: "The mucosa of the appendix is necrotic and purulent. Scattered throughout the edematous walls are polymorphonuclears. On the external surface is noted fibrinopurulent exudate. The meso-appendix shows clots within the lumen of the blood vessels."

CASE 16. F. M., white female, age 40 years, was admitted to the Presbyterian Hospital on October 11, 1936, with a history of abdominal pain which has been generalized for the past 36 hours. She has felt nauseated but did not vomit until the day of admission. The morning of admission the pain localized in the lower right side and she had a severe, shaking chill which lasted several minutes. Examination on admission revealed tenderness and rigidity all over the lower abdomen with rebound tenderness on the right side. Temperature was 100.2 degrees; pulse, 100; respirations, 20. She was operated upon soon after admission through a lower right rectus incision, an acutely swollen appendix, which was gangrenous, was found. There was no free fluid in the peritoneal cavity. When the mesoappendix was separated practically no bleeding occurred. The veins in the mesoappendix were found thrombosed and were ligated high behind the ileocecal valve. Two Penrose drains were inserted through a stab wound; the incision was closed in layers. Large amounts of thick purulent fluid drained from the wounds. The patient made a continuous progressive recovery. Her temperature was normal on the eighth day after

operation. Pathological report on the appendix was acute gangrenous appendicitis with thrombophlebitis. She was discharged from the hospital on the twenty first day after operation. Drainage had stopped and her general condition was very good.

IRRESUMPTIVE CASES

CASE 1. A L, admitted to Newark City Hospital August 10 1927 white female aged 32 years complained of weakness for 5 days with pain in the back and general malaise. Three days ago she had a chill she felt feverish and began to have pain across the lower abdomen. The pain soon radiated more to the right side in both upper and lower quadrants. Several hours later she had a vomiting attack and has had several since then. Temperature on admission was 101.6 degrees pulse 120 respirations 44. Examination revealed that the abdomen was everywhere rigid, more on the right side with direct and rebound tenderness. No masses were noted. White blood count was 16,200 with 87 per cent polymorphonuclears. Diagnosis was made of an acute surgical abdomen with peritonitis secondary to an acute appendix. Operation was performed 4 hours after admission through a right rectus incision. Free purulent fluid was found in the region of the appendix which was thick and acutely inflamed. The appendix was removed. Two drains were inserted through a stab wound and 4 sliver drains under fascia. She made a good surgical recovery from the operation, but she developed a chest complication with a cough and an area of apparent consolidation at the right base. This cleared up slowly and she appeared to have an area of unresolved pneumonia. After prolonged rest in bed the right chest cleared and patient was discharged from the hospital on the forty fifth day after operation.

CASE 2. W E, admitted to Newark City Hospital October 12 1927 white male 10 years old with a history of generalized abdominal pain which radiated to the right lower quadrant, for 3 days. The pain has persisted he vomited and was given cathartic day after pain started. The next day he had a chill. He has had earaches for the past several weeks with discharging ears for several days. On admission the abdomen was very rigid board like with direct and rebound tenderness throughout. Temperature on admission was 101.0 degrees pulse 120 respirations 36. The white blood count was 12,600 with 86 per cent polymorphonuclears. Diagnosis was made of ruptured appendix with acute otitis media. Operation was performed 4 hours after admission through a right rectus incision. A moderate amount of free green purulent fluid was found. The appendix was gangrenous. The appendix was removed in the usual manner the stump burned and 2 Tenrose drains were inserted through a stab wound with sliver drains under the fascia. After operation the child continued to improve. The ear condition cleared up with irrigations. Patient made a smooth continuous recovery to be discharged on the twenty sixth day.

CASE 3. J F, admitted to Newark City Hospital January 2, 1929 white male 28 years old complained of pain and vomiting almost continuously for the past 2 days. Pain at first was generalized but now is confined to the right lower quadrant. Yesterday he had a profuse sweat followed by a 15 minute shaking chill. He has felt severely prostrated. Temperature on admission was 101.0 degrees, pulse 86 respirations 26. White blood count was 16,900 with 89 per cent polymorphonuclears. A diagnosis of acute gangrenous appendicitis with phlebitis was made. Examination revealed marked rigidity of the abdomen, extreme tenderness throughout but most marked in the right lower quadrant. Operation was done 2 hours after admission through a McBurney incision and revealed free fluid. The appendix was retrocecal and necrotic throughout. The terminal ileum and cecum surrounding the appendix also showed signs of healing necrosis with marked edema. The appendix was removed the stump inverted, and the mesoappendix ligated high. Two stab wound drains were used to the pelvis and one to the right gutter were used. Intravenous and subcutaneous fluids were given for the first 4 days. Foul thick pus exuded from the wound for 2 weeks. Patient's course was stormy, with frequent vomiting and hiccoughing and signs of localized peritonitis. Patient was discharged from the hospital on the nineteenth day after operation in good condition the wound being healed.

CASE 4. J J, admitted to Newark City Hospital, March 22 1930 white female 16 years old, complained of being seized with pain in the epigastrium. Two days before admission the pain became more severe and was accompanied by vomiting. The day before admission he had several chills. Examination showed a well developed well nourished girl acutely ill with general abdominal tenderness. Temperature on admission was 101.2 degrees pulse 122 respirations 20. The abdomen was rigid with rebound tenderness especially in the right lower quadrant. There were no masses and no obliteration of liver dullness. The diagnosis on admission was possible biliary colic with possible pancreatitis. Blood count was 8,000 with 81 per cent polymorphonuclears. The urine was negative. Patient was operated upon 8 hours after admission. A lower midline incision was made and revealed the peritoneal cavity full of buff colored pus. The appendix was removed after ligation of the base. Ileostomy was performed. Three roll rubber drains were placed in the abdomen. The postoperative course was stormy with the development of jaundice. On the second day the patient in spite of all measures developed considerable distention and vomiting due probably to peritonitis. There was profuse drainage from the wound on ninth day. Fecal drainage from wound developed and a definite fecal fistula was established. On the same day bleeding from the wound began clots of blood appeared from under dressing but no specific bleeding point could be found. Patient's course continued downhill the

pulse became more rapid and thready, and she died on eleventh day after operation. Final diagnosis was ruptured appendix with pylephlebitis, generalized peritonitis.

CASE 5 J M, admitted to Newark City Hospital January 4, 1931, 39 year old colored longshoreman, complained of severe abdominal pain around umbilicus which had been present for past week. No nausea or vomiting occurred. Several hours before admission patient had a chill. He has had a high fever during past week. Examination showed an undernourished colored male complaining of severe pain in the abdomen and having definite chill at time of examination. Temperature was 101.4 degrees, pulse, 96, respirations, 34. The abdomen was markedly rigid especially on the right side, with rebound tenderness. A diagnosis was made of ruptured appendix. Operation was performed 1 hour after admission through a lower right rectus incision. Fluid and free pus were noted in the abdominal cavity. A rubber drain was inserted. The appendix was not removed. Patient's temperature continued high. The pulse was weak, rapid, and irregular. Fluids were given freely intravenously. A post-operative chill occurred on third and fourth days. Patient succumbed on fifth day from acute suppurative appendicitis with localized abscess and pylephlebitis of appendicial vein. No autopsy was obtained.

CASE 6 E G, admitted to the Newark City Hospital October 2, 1935, white male, 26 years old; gave a history of pain in the right lower quadrant since previous afternoon. He had vomited that night and several times the morning of admission. He has been nauseated continuously. There was a history of a similar previous attack in April. Patient had a chill the previous evening and another chill immediately after admission. Temperature on admission was 104.8 degrees, pulse, 124, and respirations, 26. Examination showed direct and rebound tenderness all over the lower abdomen, with some rigidity. No masses were palpable. White blood count before operation was 21,250 with 94 per cent polymorphonuclears. A diagnosis was made of acute gangrenous appendicitis with thrombophlebitis. He was operated upon 8 hours after admission by Dr. C. MacArthur. Operative note reads: "Low right rectus incision, rectus muscle pushed aside medially and peritoneum was opened at its lateral border. Appendix was found gangrenous, firmly adherent, firmly surrounded by fresh adhesions. The ileocolic vein and its tributaries were opened and examined for the presence of thrombi. All appeared normal. The ileocolic vein was ligated about 4 inches above the ileocecal valve. Appendix was then freed with difficulty and removed. Stump inverted. Abdomen closed in layers. Two silver drains under fascia." Fluids were given intravenously after operation. Within 24 hours the temperature fell to 100.0 degrees. He made an uneventful recovery except for symptoms of acute bronchitis, a few fine râles being found at both bases.

Patient was discharged on the twenty-first day after operation.

CASE 7 J T, white male, age 42 years, was admitted to St. James Hospital on October 13, 1936, with a history of having had a dull ache in the right side of the abdomen for the past week. The day before admission the pain became severe, he vomited once. He took a cathartic and an enema, and treated himself with moderate amounts of whisky for the pain. The night before admission he had a chill lasting several minutes. On examination there was found slight rigidity in the right lower quadrant. A soft mass was noted in the right side which was acutely tender, with rebound tenderness. Temperature was 101.4 degrees; pulse, 98, respirations, 24. He was operated upon 1 hour after admission, through a McBurney incision. A gangrenous appendix was found wrapped up in omentum. The appendix was removed, the stump was inverted, and the mesoappendix was ligated high. One Penrose drain was placed in the pelvis through a stab wound. The patient had no further chills. He had a stormy course for 12 days with temperature ranging up to 103.0 degrees. The temperature was probably due to an acute bronchitis with patchy pneumonia. After the twelfth day his temperature remained normal. He was discharged on the twenty-first day after operation.

CASE 8. H D, admitted to Newark City Hospital May 10, 1936, white female, 40 years old, with a history of pain in the right lower quadrant for 2 days before admission. She vomited several times after taking a laxative. The day previous to admission she had several shaking chills with fever. She continued to vomit. The abdominal pain became more generalized. She had eaten very little since becoming sick. On admission the temperature was 102.0 degrees, pulse, 110, respirations, 28. Examination of the abdomen revealed marked generalized rigidity and tenderness which was more marked in the right lower quadrant. The urine was negative. A diagnosis was made of a ruptured appendix with thrombophlebitis of the appendicial vein. Operation was performed under spinal anesthesia through a right rectus incision 3 hours after admission. When the peritoneum was opened free purulent fluid welled up. The intestines were packed away with rubber covered sponges, and the ileocolic vein was ligated above its bifurcation about 4 inches away from the ileocecal junction. It was easily identified, and bled freely at the point of ligation. No thrombus was seen. The appendix was then sought and was found to be ruptured and separated from the cecum at its base, lying free in the peritoneal cavity. It was removed after ligation of the mesentery. The stump could not be inverted, but was tied. Three Penrose drains were inserted through a stab wound, one in the pelvis and two in the right gutter. The abdomen was closed in layers with silver drains under the fascia. Duodenal suction drainage was started as soon as patient reacted. She was given large amounts of fluids intravenously daily. She

was desperately ill from the onset, she was irrational and semicomatose a good part of the time. Abdominal distention could not be controlled by any measures. Her temperature never fell below its preoperative level and spiked well above that level each day. She died 7 days after operation with a generalized peritonitis. No autopsy was obtained. She had no chills after operation.

STUDY OF CASES

Although the number of cases in this series is small, it is the largest to be presented thus far in which the same principles of treatment have been applied, and may be summarized as follows:

Age, sex, race. A recent study of 1463 consecutive cases of appendicitis made at the Newark City Hospital (27) may be used for statistical comparison. In this large series of cases covering all types of appendicitis, 81 per cent of the total occurred between the ages of 10 and 40. The average age in the present series is within approximately the same range. The ratio of colored to white is also found to be the same, approximately 1 to 11. In the large series the sex ratio of male to female was found to be approximately equal, whereas in this group the ratio was 3 to 1 in favor of males. It will thus be seen that, unlike the ratio existing in all types of appendicitis, the condition under discussion is more frequent in men than in women. Boyd states that acute fulminating appendicitis is twice as common in the male as in the female. When the sex incidence of acute cases in the large series is studied alone, the disease is found to be twice as common in men as in women (27) concurring with Boyd. Even then, the ratio is not as high as the 3 to 1 ratio found in the 24 acute cases outlined in this paper.

Symptoms. The symptoms in these cases were those of acute appendicitis with abdominal pain which was either generalized or localized in the right lower quadrant and was associated with nausea and vomiting. The length of time between the beginning of symptoms and the time of admission to the hospital was longer in this group of cases, probably because of the chill which confused the usual clinical picture of acute appendicitis and prevented earlier admission of the

patient to the hospital and thus delayed operation. The average duration of symptoms in the patients who died was 5.5 days before operative interference. Four of these patients presented symptoms for 1 week or longer. There is thus a definite relationship between the duration of symptoms and mortality. None of the patients presented obvious complications before operation with the exception of 2, in one of whom pregnancy was advanced (18), the other jaundiced.

Diagnosis. On reaching the surgical service of the hospital, the diagnosis of acute appendicitis with pylephlebitis was made in 18 cases and immediate operations were performed. Of the 6 remaining, the diagnosis of acute appendicitis was made in 4, while immediate operation for acute pancreatitis was proposed in 1 of the others. The sixth case was that of a patient who was in the medical service for 5 days under a different diagnosis until a surgical consultation was called. These facts are cited in order to show that if the clinical entity now in question is kept in mind, that is to say, the signs of acute appendicitis with a chill, the correct diagnosis is not difficult. It is only when the chill is interpreted erroneously that delay occurs or the wrong diagnosis is made.

Complications. The main complications found in this series were peritonitis local or general and liver abscess. Of those that developed a liver abscess, 6 in number all died. In 4 patients an upper respiratory infection developed, and one patient died although the respiratory condition was not the immediate cause of death. Case 14 of the proved group deserves special recognition in that there was no preoperative chill and in that the appendix was removed without the presence of thrombosed veins being noted. The appendix however, was gangrenous. This man was without symptoms of pylephlebitis for 17 days after operation and was apparently well on the way to recovery, when one of the Penrose drains was moved. Following the moving of the drain he suffered a chill and when another Penrose drain was moved 6 days later again there were chills. The termination was fatal, and liver abscesses were found at necropsy. It is thought that the drains must have been

contiguous to small thrombosed venous radi-
cles and that the trauma caused by moving
them dislodged small emboli from within these
veins

Hospitalization In those patients who re-
covered, the stay in the hospital was found
to be that of the average case of uncomplicated
fulminating appendicitis. In most of the fatal
cases the patients remained alive for many days
after operation. This is not unusual in cases of
this nature. They live for many days after
operation has been performed, but once the
pathology is established they resist all at-
tempts at cure.

Blood cultures. Although there were 8
deaths in the series here reported, and al-
though in most instances necropsy revealed
multiple abscesses of the liver, it is to be noted
that, although blood cultures were taken in all
of them, a positive result was obtained in
only one (Case 14), and then late in the dis-
ease. The liver apparently acts as a sieve,
straining the emboli into its capillary bed.
The infected emboli then produce abscesses,
but there is no contamination of the general
stream until one or more of the abscesses
breaks into the circulation. This fact is im-
portant since undue weight may be attached
to negative blood cultures. In the light of this
experience, it has been decided that, in future,
a culture of blood from the interrupted ileo-
colic vein will be taken at the time of opera-
tion for study in comparison with systemic
blood taken at the same time.

Type of appendicitis. The operative records
in 22 of the 24 cases state that the appendix
was gangrenous. In 8 of the 22 cases it was
also ruptured. In the 2 remaining appendices,
in 1 a diagnosis of suppurative appendicitis
was made and the other was described as
"thick and acutely inflamed."

Mortality There were 8 deaths in the group
of cases here collected, a mortality of 33 per
cent. This figure is above the average rate
reported from many large clinics dealing with
ruptured or gangrenous appendices. There is
undoubtedly a relationship between the dura-
tion of symptoms and death, and it is probable
that the mortality rate can be lowered if the
disease is recognized by the physician who first
sees the patient.

There are at least two ways in which the
factor of delay affects the outcome unfavor-
ably. First, the probability of embolism in-
creases with time. Second, advanced peri-
tonitis makes identification of the site of the
thrombus and ligation of the affected vein
difficult, if not impossible. Thus, in the 16
proved cases, 5 of the patients died. In 4 of
these (Cases 2, 10, 12, 14), the diagnosis was
not made until from 4 days to 3 weeks after
the onset of symptoms; in the fifth case
(Case 9) no satisfactory ligation could be done
because of peritonitis. Of the 11 cases in
which the patients survived, 1 case (Case 1)
was delayed and 10 were recognized early but
ligation was satisfactorily performed in all.

SUMMARY AND CONCLUSIONS

1. The occurrence of a chill and typical
symptoms of acute appendicitis point to a
complicating thrombophlebitis of the appendi-
cinal vein.

2. A study is presented of appendicitis
complicated by thrombophlebitis of the ap-
pendicinal vein, with a report of 16 proved and
8 presumptive cases.

3. The treatment consists in ligation of the
ileocolic vein above the thrombus before ap-
pendectomy is performed.

4. Unless the condition is treated early and
the ileocolic vein ligated, emboli may occur,
causing either pyelphlebitis or liver abscesses.

5. It is believed that early recognition and
proper treatment of this type of appendicitis
may contribute to lowering the mortality rate
of appendicitis as a whole.

I should like to express my appreciation to Dr. E. Zeh
Hawkes and Dr. Royal A. Schaaf for their stimulation and
counsel in preparing this paper, and for permission to re-
port some of these cases.

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THE CONSERVATIVE TREATMENT OF GALL-BLADDER DISEASE

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A CRITICAL survey of the medical and surgical management of gall-bladder disease leads to the inevitable conclusion that present day therapy is inadequate. From the surgeon's point of view, the consensus is that if there is any evidence of pathological changes in the gall bladder, the structure should be immediately removed. From the internist's point of view, the use of the low fat, low cholesterol diet in conjunction with catharsis comprises the average conception of the medical management of gall-bladder disease and has remained unchanged as the treatment of choice for the past three or four decades.

We do not concur with either of these generally accepted ideas of gall-bladder management. Cholecystectomy, which for two decades has been the most popular form of surgical treatment, is not always indicated when surgery is performed, neither has it relieved the symptoms in a reasonable proportion of the cases in which it is used. Cholecystostomy has a more definite place in gall-bladder surgery than recent surgical trends would indicate. The fact that roentgenologically functioning gall bladders can be demonstrated after surgical drainage has apparently been totally disregarded. A great majority of patients with low grade right upper quadrant symptoms can be as completely or more completely relieved by proper medical management than by surgery. The inadequacy of the present popular medical management of gall-bladder disease accounts for the dominance of surgical treatment. Medical management, however, based upon the physiological principles of the biliary tract will relieve symptoms and can restore to normal roentgenological functioning, gall bladders which gave

pathological findings on previous examination.

The objective of the present study is to correlate conservative surgical ideas with medical opinion guided by recent advances in the knowledge of the physiology of the biliary tract. In our opinion the management of biliary tract disease can never be designated as solely surgical or entirely medical. We believe that there is much to be gained in the knowledge of the disease by the co-operation of clinicians who of necessity see the patients from different points of view.

As one of the chief factors concerned in the production of upper abdominal distress, the pathological gall bladder is of great significance. In a series of 850 patients seen in the gastro-intestinal clinic of the St. Luke's Hospital Out-Patient Department over a 5 year period, the gall bladder was found to be the causative agent in the majority of cases. The results obtained in this clinic on the incidence of pathological changes in the gall bladder in cases of distress referable to the gastro-intestinal tract compare favorably with statistical studies by Davis and Vander Hoof, Bladeford and Droger, and Foster, on over 7,000 patients. Table I shows the results of our findings.

TABLE I—DIAGNOSES IN PATIENTS COMPLAINING OF UPPER ABDOMINAL DISTRESS—850 CASES

Diagnosis ¹	Cases	Per cent
Gall-bladder disease	239	28.1
Functional nervousness	183	21.6
Gastroduodenal ulceration	165	19.5
Systemic causes	52	6.2
Neoplasms	37	4.3
Miscellaneous—reflex intestinal, appendix, amebiasis, ulcerative colitis, etc.	171	20.0

¹Based on objective evidence

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flow. Magnesium sulphate has been employed as a cholagogue for many years because of its action in relaxing the sphincter of Oddi. It is difficult, however, to correlate the rationale of the popular low fat low cholesterol dietary and magnesium sulphate therapy. If stasis is to be overcome, then the most physiological method of inducing evacuation of the gall bladder—the presence of fat in the duodenum—is totally disregarded. A low fat diet places the gall bladder at rest, whereas magnesium sulphate achieves a directly antagonistic action. We fail to see the logic in abandoning a physiological method of inducing gall-bladder emptying and substituting an artificial mechanism. Furthermore, according to Ivy (27), the consensus is that magnesium sulphate is not as effective as egg yolk and cream or as olive oil and oleic acid.

Although a large percentage of patients with diseased gall bladders are chronically constipated and magnesium sulphate does have a cathartic action, the end-result of its continued use is generally the development of a highly irritable bowel with accompanying reflex pylorospasm to add to the original complaints referable to the gall bladder. When this latter syndrome is produced in a patient with hyperactive visceral reflexes, the production of a gall-bladder dyskinesia often follows.

The second inconsistency in this form of gall-bladder management is the limitation of foods high in cholesterol. We have been unable to find any conclusive evidence that there is any hypercholesteremia in patients with cholelithiasis. Whitaker, quoting Fowweather and Collinson, states that hypercholesteremia is the most significant aberration of the blood in cholelithiasis, a relation between the two conditions having been often observed in patients. Andrews (15) in a series of 250 patients with gall stones made studies of the blood levels of cholesterol and found no correlation. Campbell has likewise shown that the average patient with gall stones has a normal level of blood cholesterol. In recent months we have run blood cholesterol determinations routinely on patients under our observation for gall-bladder disease. Elevations of the blood cholesterol have been found

only in those patients who have a clinically demonstrable hypothyroidism or who have or just have had obstructive jaundice.

Whitaker has also attached undue significance to the experimental feeding of diets high in cholesterol to laboratory animals. Quoting Hansen and Dewey, he states that overfeeding with lipids, or intraperitoneal injections of cholesterol emulsions, can produce an increase of cholesterol in the blood as well as masses resembling gall stones in the bile. Studies by Fox, Gardner and Gainsborough, McMaster and Elman, Andrews and Dostal (1), Jones, and others do not support these findings, and on the contrary definitely indicate that cholesterol in the diet has no relation to either the blood or bile levels. Further studies by Andrews in humans show that there is no correlation.

The factors of primary infection and re-infection in producing the pathological gall-bladder have long formed the basis of treatment in many proposed forms of management. Salicylates, hexamines, and other substances have been employed, as gall-bladder "disinfectants." Besides the irritating effect of these substances, especially the salicylates, upon the stomach outlet, it does not appear that infection plays an especially significant part. From their investigations of gall bladders removed at operation, Andrews and Henry (2) conclude that infection is only a secondary factor, mechanical factors being primary. Similar observations with conclusions that cultures of bile or tissue from different portions of the biliary tract are sterile in a considerable proportion of cases have been reported by Rehfuess and Nelson (40), Hanssen and Yurevich, and others. In this connection, one of us (H. E. M.) has cultured all bile drained from gall bladders at operation and in 50 consecutive cases was unable to obtain growth of pathogenic organisms.

In addition to the problems of stasis and infection, the third problem with which adequate medical management must cope is the liver damage associated with the pathological changes in the gall bladder. In 1918 Graham (22) reported varying degrees of hepatitis constantly present with cholecystitis. Numerous subsequent workers have reported

TABLE II—RESULTS OF BILIARY TRACT SURGERY—1823 CASES

Reported by	Year	Cases	Diagnosis	Results	
				Satisfactory	Unsatisfactory
Davis (11)	1928	144	Mixed	90.0%	9.0%
Coffey (10)	1910	524	Mixed	69.8%	30.2%
Stanton (13)	1912	90	Stoneless	51.0%	49.0%
Judd and Priestley (15)	1932	72	Stoneless	82.5%	17.5%
Judd and Priestley (15)	1932	534	With stones	76.2%	23.8%
Gillich and Gullone (1)	1931	96	Mixed	63.8%	36.2%
Howard (26) and Brown (3)	1914	63	Mixed	44.5%	55.5%

Mixed—designates both stone and non stone cases

A study of various published statistics concerning the surgical treatment of gall bladder disease suggests that surgery alone has proved inadequate in a considerable portion of the cases. A more prolonged period of observation with a more careful selection of the cases requiring surgery combined with a better understanding of the proper medical management of biliary tract disease would greatly reduce the number of surgical failures. In many instances intelligent postoperative medical management is necessary to complete the cure. Failure to develop a satisfactory medical management of many gall bladder conditions has thrown all these cases into the realm of surgery.

It is difficult, however, to evaluate the results of surgery as reported in the literature upon an equitable basis due to the different criteria of improvement used by the various authors. Some of the investigators have arbitrarily differentiated between complete and relative cures and improvement. In compiling Table II, results were considered only as satisfactory or unsatisfactory. Cases designated in the literature as improved only and not even relatively cured have been classed as unsatisfactory in this tabulation.

It is significant that the more conservative the criteria of improvement and the longer the duration of the postoperative periods of observation, the less effective were the results of surgery. In Stanton's series of 90 stoneless cases followed for an average of 3.5 years after operation, no relief was obtained by 47.0 per

cent of the patients. Following patients post-operatively over long periods of time and using similar rigid standards of cure, Howard and Brown found that 20.6 per cent of the 55.6 per cent of the patients designated as unsatisfactory in the table obtained no relief whatsoever from surgery in their cases.

The available data indicate quite definitely that approximately one third of all patients subjected to biliary tract surgery show little or no improvement after operation. Two distinct conclusions become evident: first, there is a definite need for a more careful selection of cases for operation; second, adequate medical management is a problem of paramount importance. Apparently the best subjective results are obtained in patients subjected to surgery who give histories of repeated colic, common duct stone, or chronic pancreatitis. Poorest results obtained in patients in whom cholecystitis existed without cholelithiasis.

We believe that there are several fundamental conditions which require consideration in the medical and surgical management of a diseased gall bladder. These are: (1) stasis in the biliary tract; (2) infection of the gall bladder; (3) the varying degrees of hepatitis and liver damage accompanying the changes in the gall bladder; (4) pericholecystitis with adhesions to adjacent viscera; (5) accompanying pancreatitis. The result of stasis or blocking at the sphincter of Oddi. The exact rôle of each factor in the production of the characteristic syndrome of gall bladder disease is not definite and varies in the individual patient.

As early as 1892 Naunyn postulated his well known stasis infection conception of the etiology of gall stones. Since that time numerous workers have emphasized bile stasis as one of the critical phenomena associated with the pathological gall bladder. Elimination of bile stasis or palliation thereof was the basis for Lyon's duodenal drainage therapy. Many modifications of his original technique (34, 35) have been suggested. Although some few clinicians still employ duodenal drainage the results in general are too inconstant to warrant widespread usage.

A great many chologogic preparations have been used in the past in order to stimulate bile

minimizing the place of surgical treatment. The point which we wish to emphasize is that there should be a definite revision of ideas as to just what constitutes adequate medical management and what are surgical indications.

Before discussing the surgical aspects of the problem there are certain general considerations which must be kept in mind. In the first place, the clinician attempting medical management must know that procrastination in the face of well defined surgical indications is not without hazard. As Ivy (28) has pointed out, the older a patient becomes, the higher the mortality in biliary tract operations. The second point to be kept in mind is that in the presence of multiple small stones, the sudden impaction of a calculus in the common duct is an omnipresent danger. Rehfuess and Nelson (41), in an analysis of a large number of cases, found that approximately 30 per cent of all patients with cholelithiasis present symptoms of obstruction at some time. Further studies by Judd and Marshall (31), however, indicate that complete obstruction occurs in a relatively small proportion of cases of common duct stones. In their series of 1,608 patients with common duct stone, 27 per cent had not been icteric.

Some authors have stressed the fact that primary carcinoma of the gall bladder or biliary tract has a higher incidence in patients with cholelithiasis. Vincent has recently stated that at least 70 per cent of the cases of malignant disease of the gall bladder and common duct occur in association with stones. In a series of 9,550 gall bladders removed surgically at the Mayo Clinic, Wellbrock reports the finding of 69 adenomas. Of this number, however, only 38 were associated with stones and only 2 were malignant, 1 of the latter occurring in a non-calculous gall bladder.

In the absence of other indications, there are 3 groups of gall-bladder disease which we believe will respond to physiological medical management: (1) The gall-bladder dyskinesias, (2) chronic cholecystitis where no calculi are present; (3) chronic cholecystitis with large soft calculi, few in number, and with which the patients have no, or very infre-

quent, colic-like attacks. Even in this latter group we have found that a large number of patients become relatively symptom free when treated by the methods we have described (6, 7). Such patients, however, who do not respond to a reasonable trial period of such therapy should receive surgical treatment without further delay.

As with most surgical conditions, the clinician is usually confronted with a perplexing problem when the patient either flatly refuses operation or is such a poor surgical risk that medical management is required. Such patients are not few, and we have found that the program of management as herein outlined is the most satisfactory form of palliative treatment.

WHAT ARE THE INDICATIONS FOR OPERATION IN GALL-BLADDER DISEASE?

Enumerated in their order of frequency with our opinion concerning *when* to operate, the following are definite indications:

1. *Cholelithiasis giving definite gall-stone colic.* As a rule it is advisable to permit the attack to subside or abate before operating. There are cases, however, in which the severe pain persists, the icterus increases, and the patient's condition is growing worse. In this type of acute gall bladder, early operation is preferable.

2. *Empyema of the gall bladder.* In the acute cases in which the patient has chills and fever and is definitely growing worse, immediate operation is indicated.

3. *Obstructed cystic duct with a markedly dilated gall bladder.* Such a gall bladder is often filled with white bile. Infection may develop. At times it becomes difficult to distinguish between empyema and white bile. In some cases the gall bladder may be so stained and distended with thick dark bile that it resembles a gangrenous gall bladder. In other instances the gall bladder may rupture. The condition is definitely surgical and should be operated upon when diagnosed.

4. *Obstructive jaundice.* This condition is due as a rule to a common duct stone, stricture of the common duct, or to extrabiliary tract inflammation with compression of the duct, either from a subacute or chronic pancrea-

similar findings Flint in 1930 reported a series of 34 cases in which both gross and microscopic studies from biopsy specimens removed at operation demonstrated hepatitis associated with cholecystitis in the majority of cases. Levulose tolerance tests run on the same patients closely agreed with the microscopic evidence of liver damage. T. R. Brown (8) has stated that there is good evidence that certain of chronic gall bladder cases in reality present symptoms far more referable to a diseased liver and biliary tract than to the gall bladder alone.

Many consider the existence of a hepatitis to be a definite surgical indication regardless of the severity of the gall bladder complaints. They point out the fact that were the gall bladder not removed, the hepatitis would be aggravated. Even if hepatitis has not become evident by means of laboratory and clinical studies they state that the gall bladder should be removed before liver damage does occur. Such concepts are well founded if stasis cannot be alleviated by medical management and bile is permitted to stagnate in the biliary tree. Stasis frequently affects the pancreas as well as the liver leading to subacute or chronic pancreatitis. This condition yields best to a prolonged drainage and, when present, contra indicates removal of the gall bladder, in the opinion of many authorities. It should be remembered however, that the liver and pancreas have remarkable regenerative powers, and if stagnation of bile can be prevented medically, one of the important indications for surgical intervention can be eliminated. Furthermore, it is well established that removal of the gall bladder is followed by compensatory dilatation of the entire biliary duct system due to disturbances of the pressure regulatory mechanism of the biliary tract. It is questionable whether such a reaction favors alleviation of an existent hepatitis. In this connection, Kohlstaedt and Helmer studied the hippuric acid excretion as a test of liver function, employing the method described by Quick in 1933, in a series of 22 cases of extrahepatic biliary tract disease which were subjected to surgery. The results of the test varied widely. In 3 cases tests were made after the patients had completely re-

covered from the surgical procedure. The hepatic function, which had been lowered pre-operatively, did not return to normal in any of these cases.

In a previous paper (6) we reported the results of treatment of 65 cases of chronic cholecystitis, both with and without calculi, by various methods of medical management. Patients under observation were followed at 30 day intervals with cholecystographic examination. Our findings definitely indicated that patients can be managed medically, so as to become relatively symptom free and ultimately have a roentgenologically normal gall bladder in many cases. While gall bladders with calculi did not show the roentgen improvement that the stoneless gall bladders did, the subjective improvement was consistent. Best results both subjectively and objectively from roentgenologic studies were obtained by simultaneously administering (1) ketocholanic acids¹ to stimulate the flow of hepatic bile, (2) hourly feedings of milk and cream to induce contraction and emptying of the gall bladder at frequent intervals, (3) antispasmodic medication (tincture of belladonna m. viii, elixir of phenobarbital grs $\frac{1}{2}$, t. i. d.) to diminish the irritability of the gastrointestinal tract, thereby alleviating stasis due to hypertonicity. In severe cases bed rest was necessary at the time this form of management was started.

In a subsequent study (7) the results of the treatment of an additional group of 55 cases of chronic gall bladder disease showed that a large percentage of patients were able to obtain relief upon this form of medical management.

The choice of ketocholanic acids for the purpose of stimulating the secretion of bile was based upon experimental studies upon laboratory animals (37). Our studies, carried out in collaboration with Dr. K. K. Jones indicated that greater cholerisis with less toxic manifestations could be obtained using this preparation of bile acids.

Although our observations clearly demonstrate the efficacy of medical management based upon sound physiological principles there should be no misconception that we are

¹Ketocholanic acid supplied by the G. D. Searle and Company, Chicago.

performed were studied roentgenologically from 1 to 10 years after operation. Six of the 10 patients showed a normal response to the Graham-Cole test and 8 of them were free from symptoms.

It was further observed by several of the internists on the St. Luke's staff that poor results were being obtained in the patients subjected to routine cholecystectomy. Further studies were therefore carried on by Jenkinson and Foley in the roentgenologic department. Twenty-eight patients who had been treated by cholecystostomy from 8 months to 20 years previously were subjected to a complete series of cholecystographic examinations. Seven of the patients were males ranging in age from 43 to 78 years. Twenty-one were females between the ages of 32 and 66 years. At the time of operation the gall bladders were drained from 8 days to 4 weeks. *Nineteen of these patients gave a dye response that demonstrated a gall bladder which filled and emptied normally and gave a homogeneous shadow. Two gave normally functioning gall bladders with slight defects in contour. Seven were definitely pathological.* Twenty-one or approximately 70 per cent of these patients previously subjected to surgical drainage gave a normal response.

Additional studies (H. E. M.) on private patients previously cholecystostomized showed that 68 per cent of a total of 40 patients gave a normal gall-bladder visualization. These two groups of cases show that gall bladders which have been subjected to surgical drainage can be objectively demonstrated to be capable of carrying on normal function. We definitely believe, therefore, that it is not unorthodox to endeavor to preserve the normal physiological activity of the gall bladder and biliary tract whenever possible.

In our opinion cholecystostomy is indicated:

1. Whenever, after exposing the gall bladder and carefully examining the liver and the pancreas, one finds a definite condition of subacute or chronic pancreatitis is present, with or without cholecystitis or stones, provided the gall bladder is not so diseased that it must be removed.

It is the experience of one of us (H. E. M.)

and confirmed by the writings of Archibald, de Tarnowsky, and others, that when the gall bladder is drained because of an existing chronic pancreatitis, prolonged drainage for 6 to 12 weeks is preferable to the usual few days to 2 weeks. The recurrences and the cases that continue to have upper right quadrant distress most frequently follow a short drainage period. Bile drainage gives the inflammatory changes in the pancreas the best chance for resolution, a condition which usually requires weeks and months.

2. Whenever a few stones, usually cholesterol, are found in a gall bladder which on close inspection is otherwise negative. Because it has become the container of stones is not a sufficient reason for removing the gall bladder. We are convinced that the percentage of cures in this group is just as high, if not higher, than when the gall bladder is removed. Furthermore the operation is simpler.

3. In the presence of acute empyema of the gall bladder, it is our opinion that a quick drainage operation is safer and preferable to the more prolonged cholecystectomy.

When the surgeon exposes the gall bladder and biliary tract expecting to find stones and fails to find any condition indicative of pathological changes, it is far wiser to back out than to remove or even drain such a gall bladder. The day is past when this organ should be considered a useless non-functioning vestigial structure.

Cholecystectomy is definitely indicated when a diseased, distended, stone laden gall bladder is found. In the more severe forms of biliary tract disease, it still is and probably always will be more frequently indicated than is cholecystostomy. It is not our purpose to condemn or belittle this procedure. Rather ours is a plea for a more careful individualization of every case instead of subjecting each patient with gall-bladder disease to a routine cholecystectomy.

CONCLUSIONS

1. We believe that the present conceptions of the medical management of gall-bladder disease using low fat, low cholesterol diets in conjunction with saline purgatives have no sound physiological basis.

titis or from an extrabiliary or intrabiliary tumor. Such patients should be observed carefully and be subjected to operation when the obstructive jaundice is lessening or has subsided. Even these patients, however, occasionally have to be operated upon during the acute jaundiced stage to save the patient's life.

5 *Subacute or chronic pancreatitis, usually accompanying a cholecystitis.* As a general rule such patients should be placed upon careful medical management. Operation is indicated if the symptoms fail to subside after a few weeks or if the condition is definitely growing worse. In 3 cases which one of us (H. E. M.) had, the attacks were very acute, the jaundice very marked, and the patients grew progressively worse. All 3 patients were operated upon from the second to the seventh day. In each case the gall bladder was distended and the pancreas definitely enlarged. In 1 case the swollen pancreas simulated a tumor the size of a baseball. Prolonged drainage of the gall bladder was the operative procedure in all cases. All 3 recovered.

6 *Cholecystitis.* In most instances when this diagnosis is made the patient is definitely a medical rather than a surgical problem. The majority will readily improve on careful medical management. When no improvement occurs after persistent effort surgery is justified. Usually a careful investigation of the pancreas at the time of operation will reveal changes typical of chronic pancreatitis.

7 *Gangrenous gall bladder.* This is presumably a rare condition but according to Bailey, of St. Louis, is more common than the profession realizes. It usually results from recurring attacks of cholelithiasis colic with accompanying gall bladder inflammation and fibrosis and this combined with gall stone pressure at the neck of the bladder so interferes with the circulation that an area of necrosis develops. The gangrene may be of only a small portion of the wall or may extend to include most of the organ. Rupture is not infrequent. The mortality rate is very high, especially in the older patients. It is seldom diagnosed except at operation. The threat of this condition developing is a strong argument in favor of surgery in the presence of

recurring attacks of gall bladder disease, unrelieved by medical management.

The indefinite upper right quadrant syndrome that may mean dysfunction of the biliary tract, pancreas, duodenum, or stomach rarely belongs in the field of surgery. In all of these cases the gall bladder may at times fail to visualize normally. Patients presenting these indefinite complaints should not be subjected to operation without prolonged careful medical management. It should be remembered likewise that there are probably more patients still enjoying comfortable existence with adhesions about the gall bladder or malformations of this organ than have ever been operated upon for such conditions. The majority of such patients are suffering from functional conditions only temporarily relieved by surgery. It is the surgical treatment of such patients that accounts for the high percentage of unsatisfactory surgical results.

WHEN SURGERY IS PERFORMED WHAT IS THE OPERATIVE PROCEDURE RELATIVE TO THE REMOVAL OR DRAINAGE OF THE GALL BLADDER?

It is almost unorthodox for a surgeon to express even a favorable opinion concerning cholecystostomy. In our opinion however, there are very definite physiological indications for this procedure. We concur with Ivy's view that the gall bladder that concentrates should not be removed except for very definite indications.

It has been stated by several authors in the past that the drained gall bladder never gives a normal response upon roentgenologic examination. This has been one of the strong arguments in favor of the total removal of all gall bladders. It has swung the majority of surgeons to the "ectomy," as against the "ostomy" side of gall bladder surgery. In 1927 Spurling and Whitaker examined the gall bladders of 12 patients by the Graham-Cole test after they had been subjected to surgical drainage. They found that none of the gall bladders visualized. Moore (23) in 1928 confirmed the findings of these authors. One of us (H. L. M.) was unable to substantiate these findings. Ten patients upon whom cholecystostomies had previously been

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2 On the basis of our studies of 120 patients with chronic gall bladder disease, we have found that the use of hourly feedings of milk and cream to induce contraction and emptying of the gall bladder, ketocholanic acids to stimulate the flow of hepatic bile, and antispasmodic medication to diminish the irritability of the gastro intestinal tract, effectively relieve symptoms and reduce the incidence of colic in the majority of cases

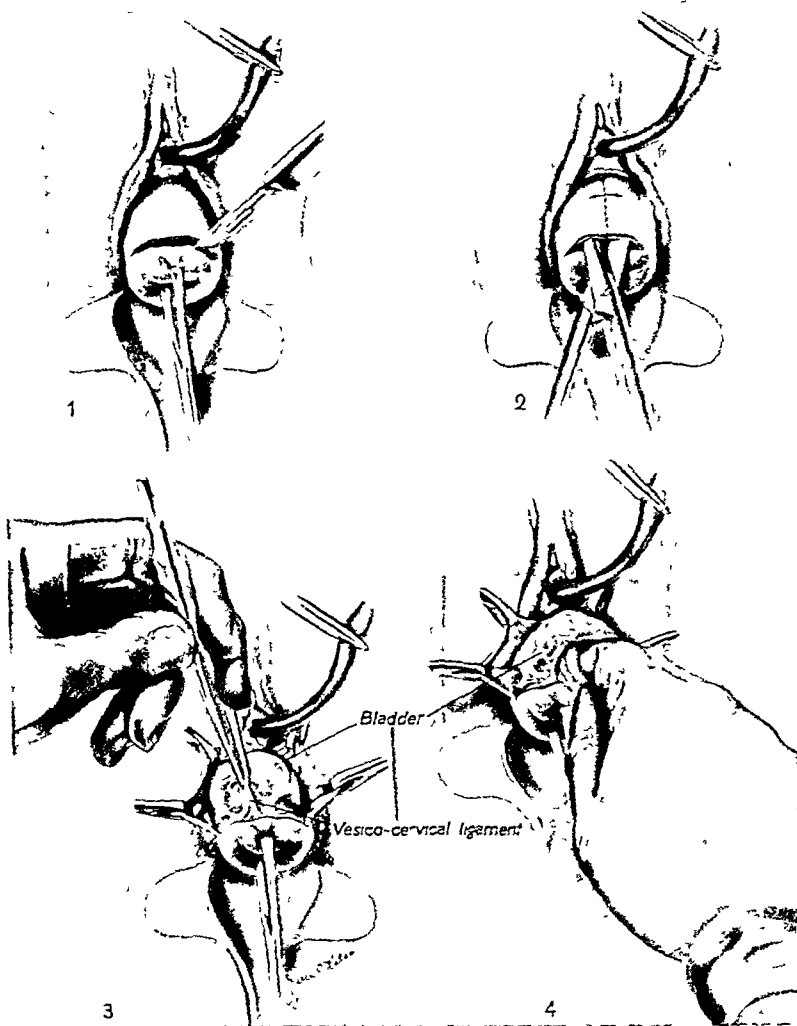
3 Statistical data indicate the persistence of morbidity in patients with gall bladder disease following approximately one third of all operations upon the biliary tract In a large number of patients, therefore, an adequate program of medical management would be preferable to surgery

4 Removal of the gall bladder does not necessarily bring relief to patients with chronic gall bladder disease, especially if associated with pancreatitis, unless colic and intermittent obstruction has been the predominant clinical picture In our opinion routine cholecystectomy is an unwarranted procedure and in many cases surgical drainage would be preferable

5 There should be a definite revision of ideas as to what constitutes adequate medical management and what constitutes indications for surgery in patients with chronic gall-bladder disease

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Figs 1 to 16 show the various steps in the operative procedure

about 1 centimeter above the anterior cervical lip. This incision is carried through the mucous membrane and the closely underlying and adherent fascia down to hard cervical tissue. There is no danger of injury to the bladder at this point as it never descends this low on the cervix even in the most extensive cystocele. If the cervix is badly lacerated or markedly hypertrophied or elongated a trachelorrhaphy or circular amputation should be performed before undertaking the next step of this procedure.

Step 2 (Fig 2). At the completion of such an operative procedure on the cervix, the upper cut edge of the vaginal mucous membrane is held with

tooth forceps and a blunt pointed dissecting scissors is gently inserted to separate the bladder from the overlying fascia attached to the anterior vaginal wall. This maneuver is easily accomplished by spreading the blades of the dissecting scissors, the blunt point being inserted well up to within 1 centimeter of the level of the urethra. The dotted line indicates the next incision, which divides the anterior vaginal wall and fascia up to a centimeter of the urinary meatus.

Step 3 (Fig 3). This median longitudinal incision through the vaginal wall and fascia is accomplished with very little bleeding and no danger to the bladder, which in this line of cleavage is very

CLINICAL SURGERY

FROM THE SERVICE OF HAKOLD BRUNN MOUNT ZION HOSPITAL

THE INTERPOSITION OPERATION WITH STERILIZATION

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THE revival of interest and excellent results reported recently in the treatment of cystocele and prolapse by the operation of interposition has prompted the writer to offer a detailed account of the modern technique of this procedure, originally described by Watkins and Wertheim. This valuable operation early fell into disrepute because of unjustified criticisms.

The occurrence of pregnancy occasionally in an interposed uterus in which the operator had failed to take proper precautions against such a complication was publicized as a condemnation of this operation. The appearance of an elongated hypertrophied cervix through the introitus following interposition was charged as a failure to cure prolapse, whereas the failure was chargeable to the operator for not recognizing the necessity of combining cervical amputation with interposition in such a case. The attempt to perform this procedure in small, contracted vaginas led to technical difficulties and disappointment in the method. Today, the sound basic principles enunciated by Watkins and Wertheim are receiving the recognition they so justly deserve by surgeons who have followed the proper indications and carefully developed a safe and simple technique in applying these principles in the treatment of cystocele and prolapse.

Cattell and Swinton report satisfactory results from the Lahey Clinic. Houston Everett, reporting from Johns Hopkins Hospital, finds this method safer and more satisfactory than vaginal hysterectomy, and Phaneuf finds it to be a very satisfactory method of treating uterovaginal prolapse in a series of 188 cases.

During the past 15 years this procedure has been used at the Mount Zion Hospital, San Francisco, in a series of 57 private and service patients who have been available for satisfactory follow-up examinations from 2 to 7 years following the operation. The results have been highly satisfactory, both from the functional and anatomical viewpoint. There have been no operative deaths in this series and but one recurrence. Eighteen of these

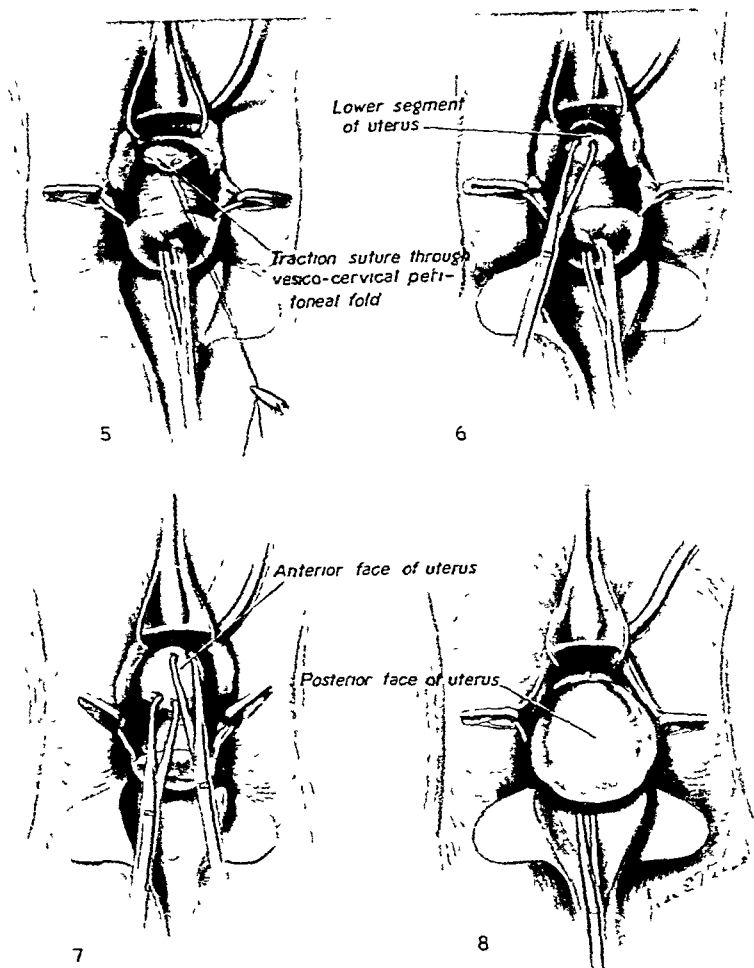
patients have been in the childbearing age; most of them in the early thirties and were sterilized according to the technique herein described. No pregnancies occurred subsequently. Contrary to the opinion expressed by many writers, I do not believe that this procedure should be reserved for only those women at or past the menopause. Young women with large families can by this method be conveniently sterilized without the necessity of abdominal section.

The indication for this procedure has been the presence of a large cystocele, with or without a moderate degree of prolapse, in patients whose uterus was not otherwise diseased or unduly enlarged. In complete prolapse, or in prolapse associated with a diseased uterus, vaginal hysterectomy has been preferred. Chaffin, who performs this procedure in all cases of cystocele as well as first and second degrees of uterine prolapse, emphasizes the contra-indication of previous pelvic laparotomy. When such laparotomy has been done for ligament shortening or pelvic inflammatory disease, adhesions may prevent the delivery of the uterus necessary for successful interposition.

Subarachnoid anesthesia has been used in the majority of these cases. If general anesthesia is used, either cyclopropane or nitrous oxide is the anesthetic of choice.

TECHNIQUE

Step 1 (Fig. 1). After the usual vaginal preparation a mushroom retention catheter is placed in the bladder and clamped. It is attached to a towel on the patient's abdomen, where it remains throughout the entire operation. This serves as a later guide to identification of the urethra. A heavy weighted vaginal speculum is inserted to hold the posterior vaginal wall toward the sacrum. The cervix is grasped with a strong tenaculum and turned downward, exposing the cystocele and completely inverting the anterior wall of the vagina, which is maintained in this position by moderate tension on the tenaculum. A transverse incision of approximately 2 centimeters is made through the mucous membrane of the anterior vaginal wall



Figs 5 to 8

Step 8 (Fig. 8). The uterus is now acutely ante-flexed and drawn out of the vagina so that only the posterior wall comes into view. The adnexa may now be visualized or palpated. If the patient is in the childbearing age, sterilization must now be performed.

Step 9 (Fig. 9). The sterilization procedure is relatively very simple and absolutely dependable in this technique. Ligatures of No. 1 chromic catgut are placed respectively 1 and 1½ centimeters from the cornual insertion of the tubes. The tubes are divided between these two ligatures. In the illustrations is also shown the traction suture which may be used in place of the tenaculum if the uterus is extremely friable.

Step 10 (Fig. 10). The principle of sterilization in this technique is dependent on the proximal portion of the tubes being ultimately bound in scar tissue outside of the peritoneal cavity. The two proximal ends of the tubes should be isolated from the distal ends by curving them forward on to the fundus and loosely approximating them to each other in this position.

Step 11 (Fig. 11). The uterus is rotated slightly to permit the distal ends of the tubes to drop back into the peritoneal cavity. The traction suture on the vesical edge of the cut peritoneum is utilized again to identify this plica of peritoneum preparatory to closure of the peritoneal cavity. If a narrow abdominal pack has previously been placed

loosely attached. Difficulty will be encountered if an attempt is made to develop a line of dissection between the fascia and the anterior vaginal wall. Such a step is not necessary and the separation of the two layers off the bladder by the method described is simple, safe and effective. The Allis clamps are attached to each of the lateral flaps of the vaginal wall and held under moderate tension by the assistants. The bladder is dissected free by sharp and gauze dissection laterally from these flaps down to the cervix. This lateral separation should be carried far enough to permit the excess of vaginal wall to be resected at the completion of the operation. In the midline, just in front of the cervix there is a fairly firm attachment by strong connective fibers between the bladder and the cervix. These fibers are called the vesicocervical or uterovesical ligament and must be divided with scissors before the bladder can be rolled off the cervix. They are held up by forceps and can be seen to be different from the bladder wall. There is danger at this point of cutting into the bladder if these fibers are not properly identified. The indwelling catheter can be used as a guide if there is any doubt as to the identification of the bladder wall from the vesicocervical ligament.

Unless the bladder is completely freed up and rolled off the cervix in this manner so that it can later lie smoothly and evenly on the posterior superior aspect of the uterus, urinary complications might follow the operation. These complications result from sacculation produced in a bladder which is unevenly compressed by the interposed uterus.

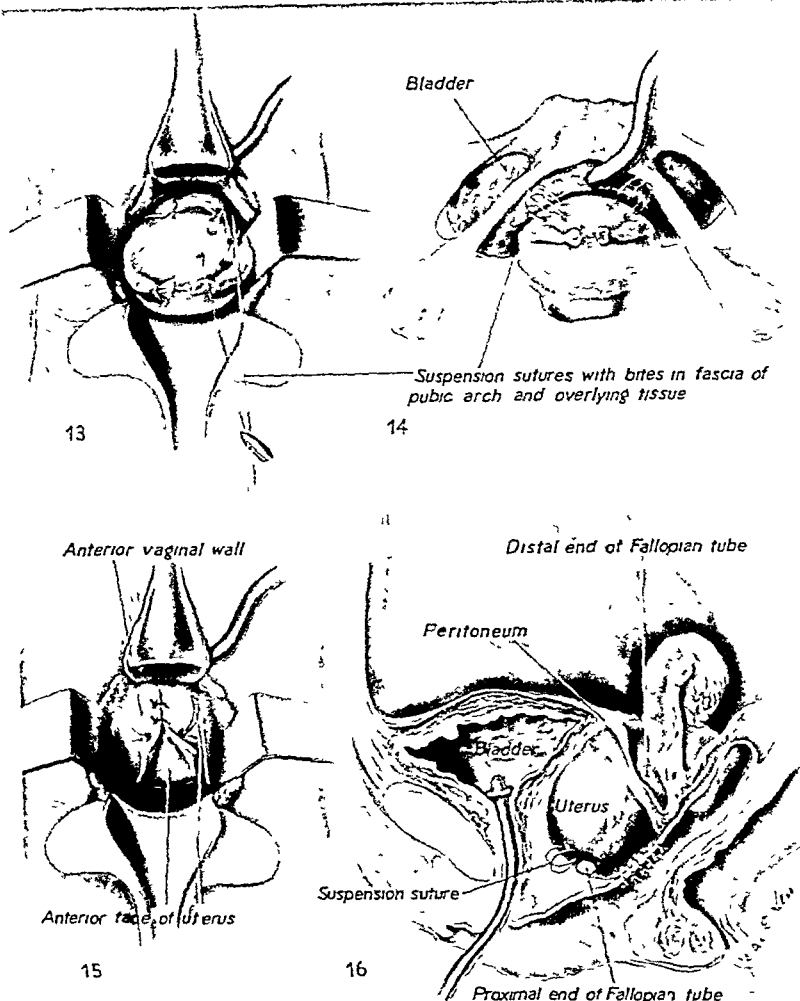
Step 4 (Fig. 4) If a clean dissection of the bladder from the lateral vaginal wall has been made and the vesicocervical ligament cut, the next important step can be easily accomplished. With a thin layer of gauze covering the gloved finger the bladder can now be gently rolled up from its descent on to the anterior wall of the cervix. This blunt gauze dissection is carried well upward in order to expose the peritoneum which at this point is called the vesico-uterine or vesicocervical fold of the peritoneum. Some difficulty may be encountered in this part of the operation if the proper plane of dissection has not been obtained. If sharp dissection has been necessary to free the bladder off the cervix there may be a tendency, in order to avoid cutting into the bladder to carry the dissection too deep into the cervix. As the dissection is carried higher and higher it will be entering a false plane lying between the peritoneal pouch and the uterus and the operator will vainly hunt for the peritoneal fold. Gauze

dissection after preliminary sharp dissection of the restraining fibers of the vesicocervical ligament usually establishes the proper plane of cleavage although in some cases the scissors may be needed to cut some resistant fibers off the bladder wall from the upper part of the cervix. If the operator frequently palpates the indwelling catheter during these steps, there will be little need of seeking a deeper or false line of dissection in an attempt to protect the bladder from injury. The blunt dissection described usually follows the line of least resistance and clearly exposes the peritoneal pouch between the bladder wall and the vesical peritoneum.

Step 5 (Fig. 5) A narrow retractor is now placed anteriorly to hold the freed up bladder toward the symphysis and to expose the peritoneal fold. This fold may often be identified by direct vision in this manner and must always be recognized by touch. If the finger presses on this fold toward the uterus and is moved back and forth the two smooth peritoneal surfaces can be distinctly felt moving on each other. A traction suture of No. 1 plain catgut is now placed through the anterior part of the peritoneal wall which is then held up and incised with scissors. As the peritoneum is opened a small amount of peritoneal fluid may escape which may give the operator the impression it is urine and that he has entered the bladder. However, by further exploration with the finger in the opening the smooth fold of the fundus of the uterus can be felt and perhaps some omentum. If the patient is straining small bowel or omentum may be forced through the peritoneal opening and it may be necessary to insert a narrow abdominal pad to keep the viscera back. This annoying complication seldom happens if spinal anesthesia is used, and the patient is in moderate Trendelenburg and a fairly high lithotomy position.

Step 6 (Fig. 6) The traction suture on the vesical edge of the opened peritoneum is now held anteriorly thus exposing the anterior wall of the lower segment of the uterus. A single hook tenaculum clamps this portion of the uterus and gently draws it forward. Care must be taken not to tear the uterus by rough traction on the tenaculum as it leads to troublesome bleeding.

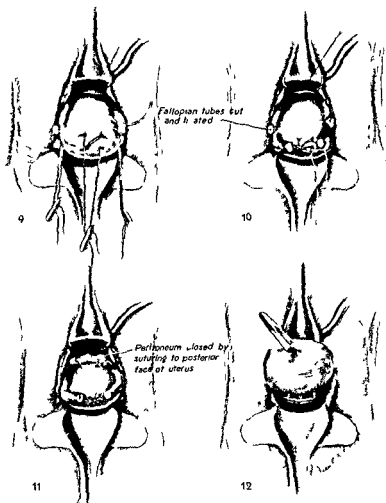
Step 7 (Fig. 7) As the uterus is drawn forward a second tenaculum is applied at a higher point on the anterior surface of the uterus. Occasionally the uterine wall is so soft that the tenaculum tears out even with slight traction. In such cases a double heavy mattress suture may be placed deep into the uterine wall so as to serve as a traction suture in order to draw the uterus out of the peritoneal cavity.



Figs 13 to 16

fixation sutures described by Crossen for suspending the uterus in its new position, are used. They are entirely buried and have proved very satisfactory. I believe they are largely responsible for the absence of recurrences and the firm fixation of the uterus to the pubic edge. No 3 chromic catgut is used as there may be considerable tension on these sutures. A bite is first taken high up at the angle of the pubic arch, a hemostat first being placed on the short end of the suture. This bite of the needle is into tissues that have a firm attachment to the pubic bone. The needle is passed through these tissues, then carried deep into the fundus of the uterus and back to take a second

firm bite into the fascia-like tissue of the pubic arch, and carried by the same hemostat holding the short end of the suture. A similar suture is placed on the other side. If both of these suspension sutures have been satisfactorily placed, the hemostats are removed and, by gentle traction on the two ends of the suspension sutures, the uterus is slowly rotated anteriorly as the anterior bladder retractor is removed. The fundus of the uterus is then placed snugly under the pubic arch exerting some pressure on the urethra. The degree of pressure on the urethra can be estimated before the final step of tying the suspension sutures is completed.



Figs 9 to 12

in the peritoneal cavity it is now removed. The peritoneum is attached to the posterior wall of the body of the uterus by two interrupted catgut sutures closing the peritoneal cavity, and making the operative area entirely extraperitoneal. In the illustrations the vesical flap appears fixed somewhat too high on the posterior aspect of the uterus. It is important that this suture line be placed low at approximately the level of the junction of the cervix and the body of the uterus.

Step 12 (Fig 12) The fundus of the uterus is rotated toward the peritoneal cavity thus exposing the anterior wall. It may occasionally be possible easily to demonstrate the cut uterine edge of the peritoneal fold by this maneuver and to suture

it with two or three interrupted catgut sutures to the anterior wall. However this step is not absolutely essential and may be omitted if technically difficult.

Step 13 (Fig 13) In order to fix permanently the fundus of the uterus under the pubic arch so as to act as a shelf for the replaced bladder Watkins originally described the crown suture which passed through the vaginal mucosa from outside included the fundus of the uterus and passed out the other side of the vaginal mucosa, the knot finally being tied above the vaginal mucosa after its closure. This suture tends to produce painful swelling and occasional pressure necrosis. In this technique two suspension sutures, similar to the

HALLUX VALGUS

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IN 1904 W. L. Keller in the *New York Medical Journal* published a description of an operative procedure for the correction of hallux valgus. This procedure involved the removal of the proximal articular end of the first phalanx together with the prominence on the internal aspect of the first metatarsal head. At the time of this publication 3 cases were reported with satisfactory results. This operation has been described in American literature from time to time, but has never attained wide popularity.

Abroad during the last 10 or 15 years, there has been a rediscovery of the Keller operation, and it has become particularly associated with the name of Brandes, who has been one of the chief exponents of the method. Altogether about 750 cases have been reported with results so satisfactory that by many authorities this procedure is recommended as the preferential one.

In 1930 Timmer stated that reports of 25 different methods for the operative correction of hallux valgus have been published. This estimate is surely conservative. The great number of methods is indicative of the unsatisfactory state of the operative methods in vogue.

In view of the favorable experience on a larger series of cases abroad of one of the authors (H. J.) with the Keller-Brandes type of procedure, we have determined to evaluate the comparative merits of this operation, for we feel that the results in a small series of cases would warrant recording.

We would first discuss briefly some of the anatomical and pathological aspects of hallux valgus which have a direct bearing upon the operative relief of this condition. Hallux valgus is usually not a congenital but an acquired deformity. Most of these deformities are caused by mechanical conditions which result from a pes plano-valgus transverso-planus. The valgus position of the heel and tarsus is the original deformity in the causative train. The pressure of the foot on the ground while the patient walks causes the abduction of the forefoot and the supination and dorsiflexion of the first metatarsal bone and great toe. The falling of the metatarsal arch is only relative. As a matter of fact the shifting dorsally of the first metatarsal head creates what appears to be a plantar prominence of the second, third, and fourth metatarsal heads. By this mechanism the

first metatarsal bone is forced into marked abduction, and this abducted position is not a primary but a secondary deformity. Due to the tension of its tendons, the great toe cannot follow this abduction of the first metatarsus, consequently it deviates and a subluxation of the metatarsophalangeal articulation occurs. Secondary productive arthritis in the first metatarsophalangeal joint may follow.

According to Hohmann a second group exists, in which the metatarsus varus is a part of a varus position of the entire foot. This type of case is decidedly in the minority, and the static group first mentioned most certainly comprises the vast majority of all cases of hallux valgus.

Inasmuch as, according to our conception of hallux valgus, the deformity is initially due to a valgus or plano-valgus, it is obvious that any operative correction can be effective only if the local causative deformity is also corrected. The correction of the entire foot before entering upon the operative phase of the treatment, is of the greatest importance in order eventually to avoid recurrence. We therefore believe that a rigid or spastic flat foot should be manipulated and corrected before an attempt is made to overcome the hallux valgus deformity. Following the hallux valgus operation, the normal position of the entire foot and correct static conditions must be maintained by means of adequate foot plates.

The Keller-Brandes operation is indicated in cases in which the hallux valgus deformity disables the patient and interferes with his work. Patients in this group who desire to be cured radically and rapidly and who wish to return to their work as soon as possible are the proper subjects for this procedure. Those patients who are mainly interested in the immediate cosmetic result of the operation should not be handled according to this method, inasmuch as full control of the great toe is re-established only after a period which must be measured in months.

TECHNIQUE OF OPERATION

The pre-operative preparation of the foot is essential, inasmuch as the skin of this area is grossly contaminated. We would particularly advise that the foot should be closely examined for evidence of fungus infections, and if such are found, a rigid pre-operative treatment should be

Step 14 (Fig 14) The suspension sutures on either side are tied, thus approximating the fundus of the uterus under the pubic arch and supporting the bladder and urethra. The new position of the urethra with the pressure on it of the uterine fundus is usually sufficient to cure the incontinence associated with the urethrocele found in the majority of cases of cystocele and prolapse. In severe cases of incontinence, a preliminary reefing of the extrinsic urethral muscle is performed as an additional step early in the operation. This is best done after the exposure of the bladder in Step 3 when the torn muscle fibers may be easily identified before the bladder is freed up and reduced into the abdominal cavity.

Step 15 (Fig 15) Closure of the anterior vaginal wall over the uterus completes the operation. If there is an excess of vaginal mucous membrane, excision of this excess on either flap is first performed. The flaps are then approximated in the midline with interrupted No. 2 chromic sutures each suture taking a bite into the wall of the underlying uterus. Closure is completed by approximating the lower ends of the anterior vagina to the anterior lip of the cervix.

Step 16 (Fig 16) In practically all cases a complete repair of the relaxed pelvic floor is done by one of the standard methods of perineorrhaphy and is essential to a successful result. Sagittal section shows the uterus now acting as a shelf which supports the urethra and bladder. The distal ends of the cut fallopian tubes are within the peritoneal cavity, whereas the proximal portions are entirely extraperitoneal and effectively prevent impregnation.

The immediate postoperative course of the interposition case is extremely satisfactory. There is practically no shock to the procedure and symptoms of abdominal distention are never present. The advantages of this procedure over laparotomy combined with vaginal plastic procedures are seen at once in the smooth convalescence. The patient has been saved the prolonged anesthesia of two separate operative procedures and pulmonary complications are proportionately lessened. The additional operative risk incident to any laparotomy is removed when the entire procedure can be done through the vagina.

Opponents of the interposition operation have stressed the high incidence of bladder complications such as dysuria and frequency. As previ-

ously pointed out in the technique, such a complication, if permanent, is due to faulty technique in failing to free up the bladder completely so that it can lie smoothly on top of the uterus when the operation is completed. The symptom of urinary incontinence in varying degrees which practically all of these patients with cystocele and prolapse present is completely cured by well performed interposition which changes the direction of the urethra and gives the urethral floor the support of the uterine fundus. Reefing of the extrinsic urethral muscles is seldom necessary, although it has been used in those few cases which have shown marked pre-operative incontinence.

The retention catheter remains in the bladder for a period of from 4 to 7 days following the operation. During the first 48 hours it is opened every 6 hours. Following this period the urine is released at 8 hour intervals and the patient is given daily bladder irrigations of 1,300 metapphen solution. When the catheter is removed the patient is usually able to void spontaneously. An occasional patient may have symptoms of a residual cystitis which responds to treatment during the first few weeks following surgery.

The average hospital stay of these patients is from 14 to 16 days.

SUMMARY

A description of the technique of the interposition operation based on an experience with 57 cases is given. This procedure has been used with excellent anatomical and functional results in the treatment of cystocele and moderate degrees of prolapse. It has been used in women during the childbearing age with the additional procedure of sterilization and has been found to have less morbidity and mortality than laparotomy combined with vaginal plastic procedures in the treatment of this condition.

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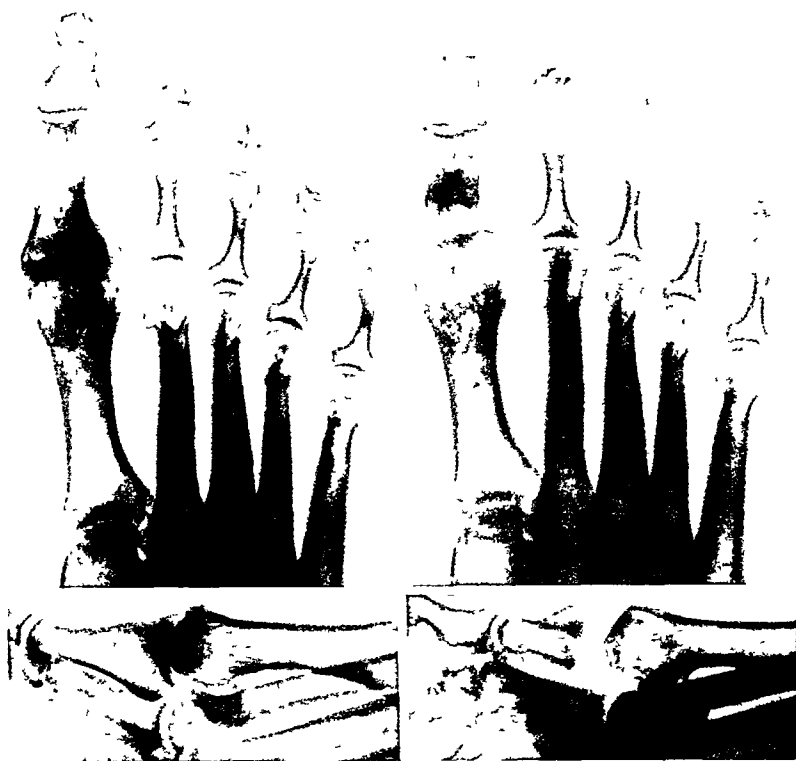


Fig 3 Left, Case 5, before operation Right, Case 5, after operation

sequent osteotomy The phalanx is now cut transversely with a bone cutting forceps The section must be made smoothly It is desirable to remove not less than the proximal two-thirds of the phalanx The removal of the bone is facilitated by the insertion of a sharp bone hook into the distal end of the proximal fragment to be used as a tractor thus exposing the plantar and internal aspects of the phalanx, so that by cutting with a scissors close to the bone, the fragment can be safely dissected and removed

The removal of the proximal two-thirds of the proximal phalanx leaves a large wide open wound, in which any potential points of bleeding can be easily recognized and ligated The fascia which usually at this stage can be found curled back laterally under the extensor tendon is sutured in place by five or six interrupted chromic sutures A few subcutaneous plain or chromic gut sutures are used, and the skin is closed with absorbable or non-absorbable material, according to the operator's inclination (Fig 2).

The aspect of the toe immediately after closure

is apt to be somewhat disconcerting to the operator performing this procedure for the first time. The digit is hypermobile, and appears simply to hang upon a collar of skin. It is of course easy to bring the toe in perfect alinement with the first metatarsal bone It is impossible for any tension to exist after this extensive resection The foot is now immobilized in plaster of Paris with the great toe held in the corrected position This may be achieved by means of a plaster-of-paris splint applied to the sole of the foot It is not desirable to remove all of the tension from the extensor and the flexor tendons, and it is equally desirable to avoid skin creases which form due to the relaxed condition of the integument of the toe following the bone resection In order to avoid undue skin and tendon relaxation and to obtain a good cosmetic result as quickly as possible, it is desirable to keep the great toe in extension or in traction while the foot is immobilized. This may be done by means of a suture through the tip of the great toe, or through its toe nail, and attaching this suture under moderate tension to a post, incor-

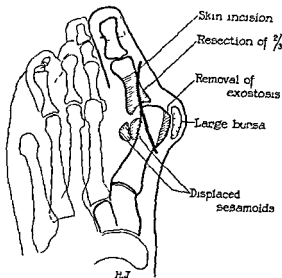


Fig. 1 Operative procedure

entered upon until this infection is entirely under control. Even in feet not infected with fungi, it is advisable to provide several days of pre operative cleansing of the feet in order to remove the abundant contamination which has been ground into the skin in the act of walking.

We prefer to operate on a bloodless field provided by the careful application of an Esmarch bandage. The use of an Esmarch bandage greatly facilitates the operation and saves time. General anesthesia is perhaps somewhat preferable to local anesthesia as there is no local trauma which might impair the nourishment of the tissues and impede the healing process. Avertin narcosis is often sufficient and, if supplemented with nitrous oxide gas and oxygen, entirely adequate. Of course if patient prefers or his general condition does not permit use of general anesthesia local anesthesia with $\frac{1}{2}$ to 1 per cent procaine solution with adrenalin gives satisfactory results.

An incision 2 to 3 inches in length is made on the dorsum of the foot beginning over the distal third of the first metatarsal bone and curving laterally around the head of the bone to the distal third of the proximal phalanx (Fig. 1). The skin is dissected from the underlying tissues and is retracted so that ample exposure is provided. Instead of using retractors we have found it most convenient to use retracting sutures which are placed at the lateral and medial skin edges and tied under the plantar aspect of the foot. Before tying these sutures gauze pads are placed under them at the skin margins. As these sutures are

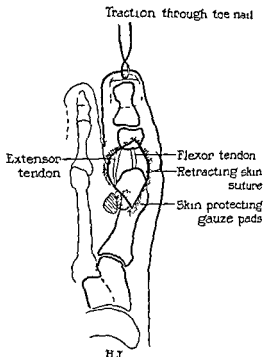


Fig. 2 Appearance before closing

tied the skin edges are retracted over the gauze pads and it is no longer necessary to employ an assistant for retraction purposes and at the same time through the mediation of the gauze pads, the wound is protected from skin contamination. The fascia is now incised longitudinally and the extensor hallucis tendon is retracted laterally. The prominence of the first metatarsal head is now exposed without removal of the overlying bursa. The capsule of the first metatarsophalangeal articulation is incised transversely, and upon exposure of the articular end of the metatarsal the groove which separates the exostosis from the head of the first metatarsal bone appears. A chisel is now driven into this groove in the direction of the longitudinal axis of the first metatarsal bone and the entire exostosis is thus removed. Any osteophytes on the dorsal and lateral aspect of the first metatarsal head are removed and the entire head of the bone is carefully smoothed. The proximal two-thirds of the proximal phalanx are now exposed by means of blunt dissection with a periosteum elevator. It is well to separate the bone around its entire circumference particularly on its plantar aspect in order that the flexor hallucis tendon should not be injured in the sub

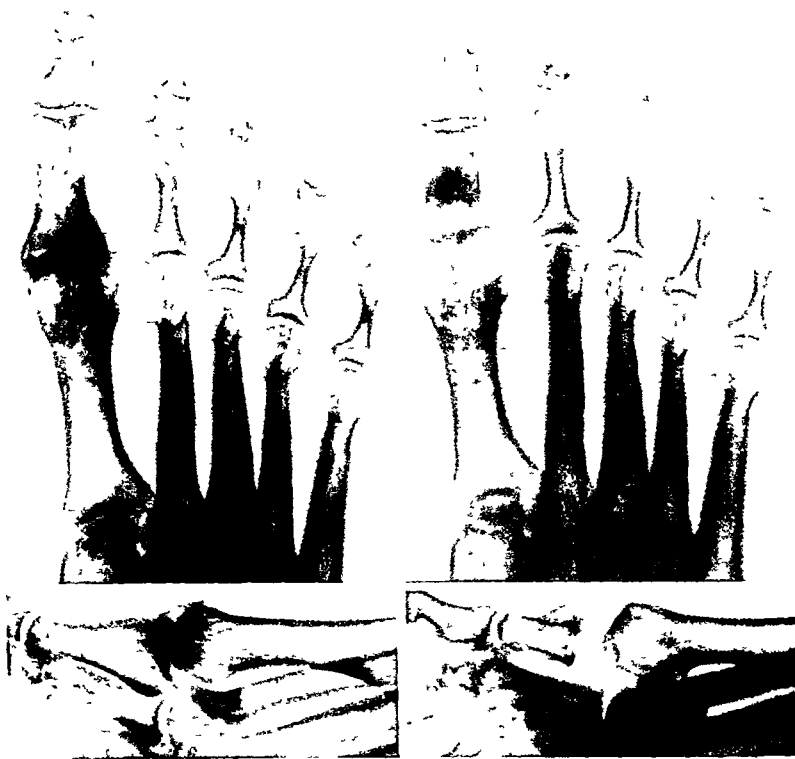


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Fig. 4 Case 6 Anteroposterior and lateral view of right foot approximately 1 year after operation

porated in the plaster of Paris dressing. The traction should be so arranged as to pull the great toe in a position neutral between abduction and adduction and in slight plantar flexion. Traction can usually be removed at end of a week. For the first few days after the operation the foot of the patient's bed should be elevated about 8 inches. This adds materially to the postoperative comfort.

As a rule, the postoperative temperature reaction is very slight and a normal level is achieved 3 or 4 days following the operation. After 5 or 6 days the patient may be out of bed in a wheel chair, and it is possible to discharge patients on whom a unilateral operation has been performed after 1 week, at this time weight bearing may be instituted in the plaster. The plaster splint is removed 8 or 10 days following operation and an elastoplast strapping is applied from the toes to the knee. Particular attention is given to the remodelling of the forefoot in order to restore the metatarsal arch and the first and fifth metatarsal bones are kept in an adducted position. Plaster casts can be made for the preparation of proper foot braces in about 2 weeks after operation. The elastoplast strapping should be applied for at least 3 weeks. Some physical therapeutic after care is desirable, particularly in older patients with poor circulation.

The majority of patients in whom only one foot has been operated upon will be able to return to work about 2 to 3 weeks after operation. Of course, it must be expected that at this time the function will not be even approximately normal. The full benefit of the operation does not become apparent until a period of 6 months has elapsed.

The operative correction of hallux valgus must be considered with the primary view of preserving or restoring with a minimum of risk, the normal physiological mechanism of the foot. Any operative procedure which seriously impairs the function of either the transverse or of the longitudinal arch of the foot is erroneous in its conception. We feel that the Keller Brandes procedure restores the normal mechanism of the foot with a minimum of risk to the patient.

By effectively removing all deforming tension on the deviated hallux this operation readily permits the proper alignment of the hallux and of the metatarsus primus varus. There is effective restoration of the contour of the anterior metatarsal arch and the integrity of the longitudinal arch is in no way impaired.

It has been urged that the operation may produce marked metatarsophalangeal arthritis. The risk of this complication is, we think, far less than in any other of the generally accepted procedures with the possible exception of the major operation. This latter, however, entirely destroys the inner pillar of the anterior and the anterior pillar of the longitudinal arches. If the advice of Brandes is followed and fully two-thirds of the proximal phalanx is removed a potential joint space of such width is provided as to render subsequent painful articular friction highly improbable.

It has been suggested that the cosmetic result of shortening the great toe is an undesirable feature of the operation. To this criticism we would urge that in the average case of bunion the great toe is unduly long so that the shortening of this digit is in most cases, entirely desirable. We would also urge that restoration of painless function and not cosmetic considerations should be the prime objective of the bunion operation and this objective we believe is most consistently fulfilled by the Keller Brandes operation.

A feature of the operation which may be urged, is the factor of safety which is provided in the occasional case in which, despite the most meticulous precautions, the wound becomes infected. The cavity which is left by the removal of the proximal two thirds of the proximal phalanx is readily drained through the operative incision, and the simple early opening of a few sutures converts the zone of infection into a single, effectively



Fig 5 Left, Case 7, before operation Right, Case 7, after operation

drained pocket. There is no necessity for multiple drainage incisions and the diastasis between the component bones of the articulation again renders the advent of arthritis less probable and absolute ankylosis is certainly not to be anticipated, even after a fairly severe infection.

The operation must also be considered from its applicability to conditions allied with, or frequently complicating, hallux valgus. In those cases in which hallux rigidus is present with or without a valgus position of the great toe, this procedure is spectacular in its efficacy. The complication, sesamoiditis, which so often attends deformations of the forefoot can be effectively coped with during this procedure. The removal of the phalangeal section makes the approach to the sesamoids a simple task and the removal of these ossicles, if desirable, is effected readily.

During the past 2 years 11 of our patients have been operated upon by the Brandes-Keller procedure for hallux valgus or hallux rigidus, in 4 cases on both feet simultaneously, thus giving a total of 15 hallux valgus operations of this type.

CONCLUSION

1. The Keller-Brandes operation for hallux valgus (or rigidus) in which the proximal two-thirds of the proximal phalanx of the great toe, together with any attending exostosis is removed, affords a simple and safe method for coping with all of the deforming influences producing this deformity.

2. The period of postoperative disability is shorter than that of the average exostosectomy.

3. The ultimate cosmetic and functional results are gratifying both to the patient and to the physician.

4. The postoperative morbidity is slight.

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INSTRUMENTAL DILATATION OF THE PAPILLA OF VATER

Experimental and Clinical Observations

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THE indications for exploring the common bile duct in operations for cholelithiasis have been fairly well established. Statistics (20) show that calculi are found in the common bile duct in approximately 20 per cent of all cases; if exploration of the common bile duct is performed in as much as 40 per cent of such operations. Various methods have been recorded for exploring the common bile duct in order to remove calculi and to determine the patency of the papilla of Vater. In some instances, these steps are followed by dilatation of the papilla. Those who favor this further procedure believe that it promotes the passage of calculi and debris not removed by careful scooping and irrigation of the bile ducts. They feel that a more satisfactory drainage of bile into the duodenum will also be maintained.

It has been our custom to follow the method of Cheever in this operation. This involves the passage into the common bile duct of a No. 10 F soft woven catheter, which is the size of the average papilla in the human being. Saline is injected through the catheter to establish the patency of the ampulla by the visible filling of the duodenum. The injection of saline is continued while the catheter is slowly withdrawn in order to dislodge and force overlooked calculi into the opening of the common bile duct. Following this catheters of size No. 16 F are passed but rarely those of larger caliber. Allen has recommended the use of Baké's metal dilators for extensive dilatation of the papilla of Vater even up to the size of the common bile duct itself so as to permit overlooked calculi to escape. Allen and Wallace and Baké have recorded instances of the passage of calculi in the stools following such dilatation. These apparently had been overlooked at the time of operation. We have not encountered any serious complication directly attributable to the catheter method of dilatation of the papilla. However, the possibility and dangers of duo-

denal reflux have been emphasized (9, 16). Lahey has reported 2 deaths following the use of Baké's dilators which he states were the result of over dilatation of the papilla of Vater. All of the various methods of dilatation accomplish the important step of making certain of an unobstructed communication with the duodenum. We have considered whether greater dilatation of the papilla is of sufficient value to the patient to overshadow the dangers associated with extensive stretching of its tissues. In order to study this problem experiments on dogs were carried out to determine both early and late effects of the methods of dilatation on the papilla of Vater. We believe that the anatomic details in this region are sufficiently similar to allow the application of data obtained from dogs to patients. The recent study of Boyden compares this region in man and various animals. In the dog the pancreatic duct and the common bile duct open separately into the duodenum but there is a two layered musculus proprius comparable to that of man.

EXPERIMENTS

Experiments were carried out on more than 50 dogs to study the effects of various degrees of dilatation on the papilla of Vater, liver, and extrahepatic bile ducts. In each dog the papilla was dilated transduodenally by one of the two previously mentioned methods. This was done with and without cholecystectomy and at short and long intervals following removal of the gall bladder. Gross and microscopic studies were made from normal controls. The caliber of the papilla in normal dogs obviously varies with the size of the animal but we have accepted a No. 20 F as the average in the dogs in this laboratory (Table I). Reports (3, 8, 11, 12, 17, and 18) have indicated that within 120 days cholecystectomy is followed by spontaneous dilatation of the biliary duct system. In order to determine the amount of this dilatation alone cholecystectomy without dilatation of the papilla of Vater was performed on 6 dogs. After 4 months the size of the papilla had increased to No. 14 F. In the

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TABLE I

Type of experiment	No. of animals	Survival days	Ampulla dilated to	Size of ampulla
Control				10 F.
Cholecystectomy	6	120		14 F
Cholecystectomy and catheter dilatation	7	96	18 F	10 F
Cholecystectomy and Bakés dilatation	5	63	17 F	12 F
Catheter dilatation	5	135	21 F	10 F
Bakés dilatation	3	120	23 F	10 F
Dilatation and cystic duct drainage	4	92	21 F	11 F
Dilatation 200 days after cholecystectomy	6	100	20 F	12 F
Acute experiments	15	1-28	22 F	

first series of experiments, an attempt was made to pass catheters through the stump of the cystic duct. This proved a difficult procedure in the dog, for it was impossible to secure considerable dilatation of the papilla without tearing the common bile duct. Because of this, transduodenal dilatation was used. In 7 dogs, cholecystectomy was followed by dilatation of the papilla with catheters by the transduodenal approach to an average size of No. 18 F. These dogs were examined on an average of 96 days following the operation, and it was found that in all of them the papilla had returned to normal size. The Bakés metal dilators were used in a group of 5 dogs to dilate the papilla to sizes averaging No. 17 F. Sixty-three days following operation, autopsy showed the papilla to have returned to approximately normal measurements, in this instance No. 12 F.

Since cholecystectomy alone produces an enlargement of the papilla of Vater, the effect of transduodenal dilatation without cholecystectomy was studied. In 5 dogs the papilla was dilated by catheters and in 3 dogs by the use of metal dilators, to No. 21 F. and 23 F., respectively. After a period of at least 4 months, the average measurement of the papilla was found to be No. 10 F.

In a group of 4 dogs, an attempt was made to simulate the method used in the human being by removing the gall bladder and draining the common bile duct by a catheter introduced through the cystic duct. The papilla was then dilated by the transduodenal method, the Bakés dilators being used, to an average size of No. 21 F. These dogs were sacrificed after a period of 3 months, and it was found that the papilla had returned to No. 11 F. in caliber.

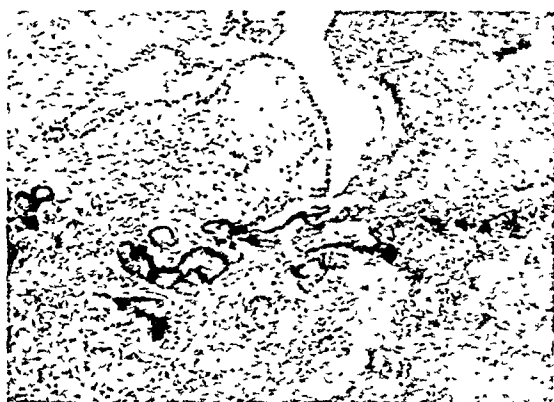


Fig. 1. Photomicrograph of the papilla of Vater 3 days after dilatation with Bakés instrument. The lumen, at the right, is filled with fibrin and leucocytes. The mucosa is interrupted and shows acute inflammatory reaction. $\times 90$.

The papilla of 6 animals was dilated transduodenally on an average of 200 days after removal of the gall bladder. This was done to determine the effects of dilatation on a pathological biliary system. Graded catheters were passed through the papilla to an average size of No. 20 F. The average size of the papilla 100 days later was only No. 12 F. These experiments indicate that the papilla after extensive dilatation returns to a size smaller than that after cholecystectomy alone.

In addition, a study was made of the immediate effects of dilatation. The papilla was dilated to a No. 22 F. in a series of 15 dogs. These were sacrificed at intervals varying from 1 to 28 days. Gross examination at the time of sacrifice showed, in the first week, that there was a large, edematous papilla protruding into the lumen of the duodenum. No attempt was made to measure the actual size, to obtain microscopic sections which had had no other trauma than that occurring at the original dilatation.

MICROSCOPIC STUDIES

Histologic examination of the papilla of Vater showed that the early changes in the region of the papilla were those of hemorrhage and acute inflammation. In the specimens examined 1 to 3 days after dilatation, the continuity of the epithelium was broken in many places and these intervals were filled with fibrin and polymorphonuclear leucocytes. This exudate was so extensive as to fill the lumen almost entirely (Fig. 1). In addition, there were rather large areas of hemorrhage in the surrounding tissues. The portions of mucosa not eroded showed edema and infiltration with polymorphonuclear leucocytes.

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THE indications for exploring the common bile duct in operations for cholelithiasis have been fairly well established. Statistics (20) show that calculi are found in the common bile duct in approximately 20 per cent of all cases if exploration of the common bile duct is performed in as much as 40 per cent of such operations. Various methods have been recorded for exploring the common bile duct in order to remove calculi and to determine the patency of the papilla of Vater. In some instances, these steps are followed by dilatation of the papilla. Those who favor this further procedure believe that it promotes the passage of calculi and debris not removed by careful scooping and irrigation of the bile ducts. They feel that a more satisfactory drainage of bile into the duodenum will also be maintained.

It has been our custom to follow the method of Cheever in this operation. This involves the passage into the common bile duct of a No. 10 F soft woven catheter which is the size of the average papilla in the human being. Saline is injected through the catheter to establish the patency of the ampulla by the visible filling of the duodenum. The injection of saline is continued while the catheter is slowly withdrawn in order to dislodge and force overlooked calculi into the opening of the common bile duct. Following this catheters to size No. 16 F are passed, but rarely those of larger caliber. Allen has recommended the use of Baké's metal dilators for extensive dilatation of the papilla of Vater even up to the size of the common bile duct itself so as to permit overlooked calculi to escape. Allen and Wallace and Baké have recorded instances of the passage of calculi in the stools following such dilatation. These apparently had been overlooked at the time of operation. We have not encountered any serious complication directly attributable to the catheter method of dilatation of the papilla. However, the possibility and dangers of duo-

denal reflux have been emphasized (9, 16). Lakey has reported 2 deaths following the use of Baké's dilators which he states were the result of over dilatation of the papilla of Vater. All of the various methods of dilatation accomplish the important step of making certain of an unobstructed communication with the duodenum. We have considered whether greater dilatation of the papilla is of sufficient value to the patient to overshadow the dangers associated with extensive stretching of its tissues. In order to study this problem experiments on dogs were carried out to determine both early and late effects of the methods of dilatation on the papilla of Vater. We believe that the anatomic details in this region are sufficiently similar to allow the application of data obtained from dogs to patients. The recent study of Boiden compares this region in man and various animals. In the dog the pancreatic duct and the common bile duct open separately into the duodenum but there is a two layered musculus proprius comparable to that of man.

EXPERIMENTS

Experiments were carried out on more than 50 dogs to study the effects of various degrees of dilatation on the papilla of Vater liver and extrahepatic bile ducts. In each dog the papilla was dilated transduodenally by one of the two previously mentioned methods. This was done with and without cholecystectomy and at short and long intervals following removal of the gall bladder. Gross and microscopic studies were made from normal controls. The caliber of the papilla in normal dogs obviously varies with the size of the animal but we have accepted a No. 20 F as the average in the dogs in this laboratory (Table I). Reports (3, 8, 11, 12, 17, and 18) have indicated that within 120 days cholecystectomy is followed by spontaneous dilatation of the biliary duct system. In order to determine the amount of this dilatation alone cholecystectomy without dilatation of the papilla of Vater was performed on 6 dogs. After 4 months the size of the papilla had increased to No. 14 F. In the

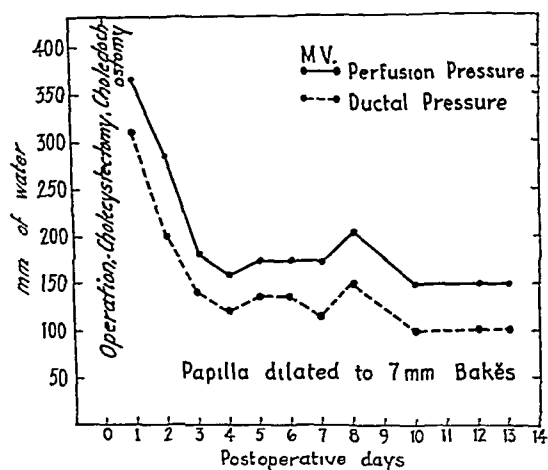


Fig. 4. Chart showing the high initial rise and subsequent fall of the perfusion and ductal pressures in a patient in whom the papilla was dilated to 7 millimeters (Bakès)

of overlooked calculi it would seem that the perfusion pressure in these patients should be very low. Colp and his associates (7 and 10) have shown that any irritation to the papilla will cause temporary sphincteric spasm. From this it would seem that severe trauma to the sphincter from dilatation may cause prolonged spasm and thus prevent the passage of bile and calculi into the duodenum. Using methods described by Doubilet and Colp (10) and Butsch and McGowan we have followed in patients the pressure necessary to overcome the resistance of the sphincter immediately after dilatation of the papilla. As a control we inserted a catheter into the stump of the cystic duct, or into the common bile duct in other patients to determine the sphincteric resistance when there has been no manipulation. The resistance of the sphincter in a normal human individual is approximately 150 millimeters of water. To avoid the effect of morphine on the sphincter, readings were not taken until 6 or more hours following its administration. In a patient (Fig. 4) in which there had been dilatation of the papilla following choledochostomy to No. 22 F. (Bakès 7 mm) dilator, the sphincteric resistance was approximately 370 and the persistent ductal pressure was 300 on the day following operation. There was a fall in this sphincteric resistance over a period of several days, but it did not reach a normal level until approximately 4 days following operation. This is also true of the ductal pressure. The findings have been constant in 6 additional cases. In 3 patients in whom we have been able to introduce a very small catheter

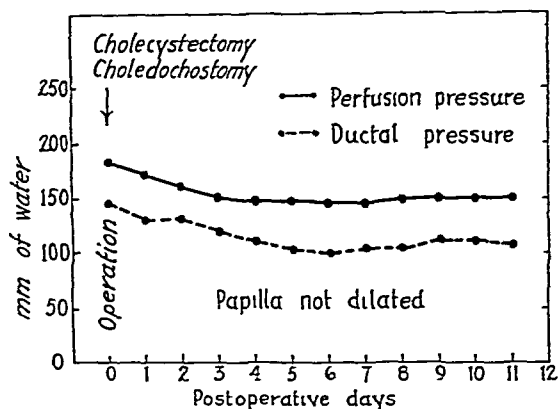


Fig. 5. Chart showing absence of initial rise in perfusion and ductal pressures in a patient in whom choledochostomy was performed without dilatation of the papilla of Vater

through the stump of the cystic duct or directly into the common bile duct without manipulation of the papilla, the sphincteric resistance remained at about the normal limits, both on the day of operation and in the following days (Fig. 5). These findings are comparable to the microscopic study, which shows the lumen of the papilla filled with exudate and encroached upon by the edematous mucosa for several days after extensive dilatation of the papilla of Vater. From this it is suggested that in cases in which such dilatation of the papilla has been carried out, the sphincteric resistance does not fall below the normal limits during a period of 2 weeks after operation. As Doubilet and Colp have stated, the hydrostatic pressure caused by the bile does not act against the sphincter but forces the bile through the catheter, since less pressure is required to do this than to overcome the sphincteric resistance.

This resistance, as indicated by our experiments, following the extensive dilatation of the papilla of Vater in patients, suggests that such a procedure would be unwise if plastic operations are to be carried out on the common bile duct. The belief that incisions in the common bile ducts cannot be closed with safety after exploration of this structure may also depend on the increased ductal pressure resulting from morphine during the post-operative period, as shown by Walters and his associates (15 and 19). Irritation from the passage of instruments through the papilla of Vater may increase the pressure still further.

SUMMARY

An investigation has been carried out to determine the effect of extensive dilatation of the papilla of Vater to permit the escape of overlooked

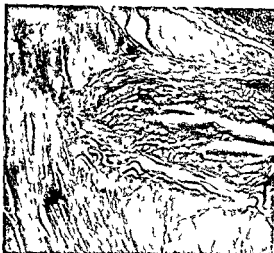


Fig 2 The normal papilla of Vater of a dog showing intact layers of musculature separating the mucous membrane from the duodenal wall $\times 13$

At the end of a week the lumen of the papilla had reached approximately normal size and most of the exudate had disappeared. The continuity of the epithelium was almost completely restored. In the mucosal stroma there were many lymphocytes but polymorphonuclear leucocytic reaction was slight. There were many fibroblasts and some newly formed capillaries throughout the mucosa and in the layers of muscle ensheathing the papilla. Sometimes these even extended into the adjacent intestinal musculature for a short distance.

After one month considerable scar tissue had formed. This was in contrast to the normal dog's papilla, in which there is an intact investment of muscle about the terminal portion of the common bile duct (Fig 2). The scar tissue extended through the muscle at intervals and even involved the duodenal muscularis occasionally. The mucosal epithelium was complete but the glands appeared somewhat altered in outline and in the stroma about them were numerous lymphocytes and some plasma cells (Fig 3).

In the specimens of the papilla from dogs with a greater interval than a month between operation and autopsy, the only further changes were the progressive increase in the collagen of the scar tissue and its retraction. There was no further demonstrable alteration in the contour of the lumen of the duct. The lymphocytic reaction was not noticed after an interval of 2 months.

Sections of the liver were compared with con-



Fig 3 Papilla of Vater 1 month after dilatation of the papilla with Bakes instrument. Note the area of scarring and interruption of the musculature $\times 13$

trols from normal dogs and from dogs after cholecystectomy alone. Also in most experiments biopsies of the liver were obtained. We found no instances of marked hepatitis. In those dogs with strikingly dilated intrahepatic bile ducts there was some increase in connective tissue over that seen in controls but not to a great degree. Lymphocytes were only slightly more numerous about these ducts than in normal controls. The degree of normal variation seemed to us considerable.

CLINICAL APPLICATION

Autopsy statistics show that calculi are overlooked at exploration of the common bile duct in approximately one third of the cases (14). Because of this, any method which may tend to improve these results seems indicated. The experimental evidence tends to show, at least in animals, that the outlet of the duct is partially blocked by edema and the outpouring of exudate after extensive dilatation. Within a relatively short time the papilla returns to a size smaller than it would have been following cholecystectomy alone. Although such contracture seems a definite possibility, presumably on the basis of scar tissue formation, no serious late results have been recorded attributable to extensive dilatation of the papilla of Vater.

An estimate of the state of the papilla of Vater immediately after dilatation in patients was attempted by the use of the perfusion method, described by Butsch and McGowan. If the papilla is sufficiently dilated to permit the escape

CONDUCTION ANALGESIA IN ANORECTAL SURGERY

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ORIGINATED by Braun and modified by Allen, de Takats, and Werner as infiltration anesthesia, this method is termed conduction analgesia because the injections are made deliberately to analgesize the conducting pathways to the anorectum. Such planned procedure is in contrast to the random injections of infiltration or block analgesia. The term analgesia is used to signify abolition of pain sensation with no loss of cerebral functioning (4). Here the protopathic sensation is retained but the epicritic is lost. Since the conducting pathways are enveloped by the analgesic solution, the nerves are affected by diffusion (8).

This method of analgesia has been employed with excellent results in the surgical treatment of selected cases of internal and external hemorrhoids, prolapse, moderate procidentia, polyps, fissures, fistulas of the simple, straight variety, inflamed crypts, hypertrophied papillas, intranal ulcers, condylomas, and skin tags. In divulsion and removal of certain foreign bodies it may also be used. It is not applicable, however, when the extent of the disease process has not been determined before operation, when free suppuration is present, when there are present massive condylomas, multiple and complicated fistulas, or malignant tumors in which extensive surgical intervention is required and the growth is located in the region above the peritoneal reflection. These and such conditions as sequestration, dermoid cyst, stricture, procidentia recti, congenital anomalies, and imbedded foreign bodies, are better treated under general anesthesia or spinal analgesia.

PREPARATION

Two hours, and, again, one hour, before operation the patient receives by mouth 3 grains of sodium amytal or $1\frac{1}{2}$ grains of nembutal. At operation, the patient assumes the exaggerated lithotomy position, with the buttocks well over the edge of the table and a large pad under the sacral region. He is then placed in a slight Trendelenburg position and, to add to his comfort, a pillow is slipped under his head so as to raise it to the level of the pubis. In the male, a Drueck binder is applied in order to omit the scrotum

from the operative field. The anal and perianal skin are then painted with the following solution: picric acid, 5 per cent; acetone, 20 per cent; alcohol, 5 per cent; and water. The excess is dried with sterile gauze.

ANALGESIC SOLUTION

Procaine 1 per cent, or nupercaine 0.1 per cent (1:1000), or metycaine 1 per cent may be used, with the addition of adrenalin in the proportion of 2 to 3 drops to the ounce, to prolong the analgesic effect. The solution should be freshly prepared.

TECHNIQUE

Step 1 With a $\frac{3}{4}$ inch, 24 gauge hypodermic needle to which is attached a small syringe, an intradermal wheal is raised in the posterior midline, approximately three-quarters of an inch behind the anus. For this, only a few minims of the solution are necessary.

Step 2 A 3 inch, 22 gauge needle attached to a 5 cubic centimeter syringe is introduced through the wheal, and, with the index finger in the anal canal as a guide, the needle is slowly advanced parallel and posterior to the canal for a distance of approximately $1\frac{1}{2}$ inches. At this site, 10 cubic centimeters of the solution are deposited. If the patient feels discomfort, a few minims may be injected as the needle is advanced. The syringe is then detached and the needle is withdrawn up to, but not through, the wheal.

Step 3 With the finger in the rectum as a guide, this same needle is slowly inserted on the left side, deeply, forward, and outward, to the full extent of the needle, depending on the fullness of the buttocks. The syringe, charged with the analgesic solution, is now attached and 5 cubic centimeters are slowly injected into this area. Again the needle is withdrawn up to, but not through, the wheal.

Step 4 The needle is then inserted on the right side and the same procedure is followed as in Step 3. The posterior quadrant has now been completely injected, 5 cubic centimeters being used in the midline and 5 cubic centimeters on either side.

Step 5. With the technique described in Step 1, the second intradermal wheal is raised in the anterior midline, approximately a half inch in front of the anus.

calculi. Experiments on dogs suggest that damage may be done to the papilla of Vater by dilatation, with hemorrhage and inflammation in the acute stages. Later there is scarring resulting in a smaller opening than that which follows cholecystectomy alone. Clinically, perfusion pressures in patients during the postoperative period following exploration of the common bile duct with dilatation of the papilla show that there is a greater pressure when the papilla is extensively dilated than in those in whom it is not explored. We believe that it is sufficient to determine the patency of the papilla of Vater by the passage of moderate sized instruments instead of attempting to dilate it.

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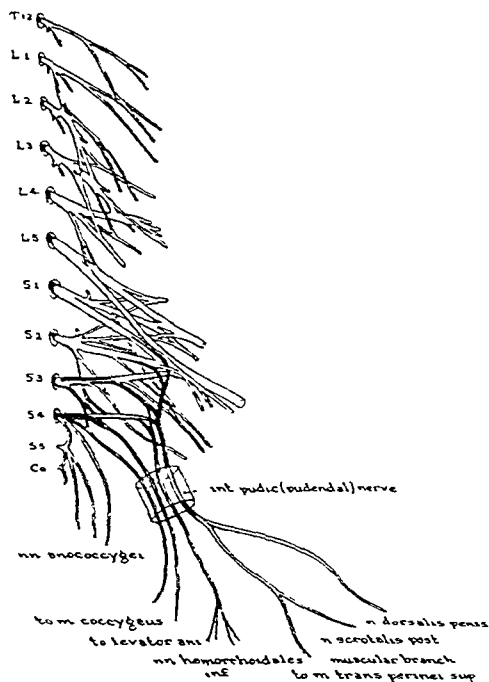


Fig 5 Nerves to the anorectal area showing their origin in the sacropudendal plexus

POSTOPERATIVE ANALGESIA

Prolonged analgesia may be obtained by the injection of 5 cubic centimeters of diothane, $\frac{1}{2}$ per cent solution, into the substance of the sphincter muscles (2, 3). In a series of approximately 450 cases treated by the author, freedom from severe pain was a constant feature in all but 11. Similar experiences have been reported (6, 9, 10).

PURPOSE

The anterior and posterior intradermal wheals serve to obtund the skin filaments and render subsequent injections painless. The posterior midline injection interrupts the posterior branch filaments of the inferior hemorrhoidal nerves, the anococcygeal nerves just below their perforation through the sacrotuberous ligament, and the perineal branch of the fourth sacral as it pierces the coccygeal muscle.

The posterolateral injections serve to analgesize the inferior hemorrhoidal nerves at a higher level, together with the perineal nerve and its posterior scrotal or labial branches, and the muscular branches of the dorsal nerve to the penis or clitoris.

The anterior midline injection inhibits the posterior scrotal nerves, its communicating fila-

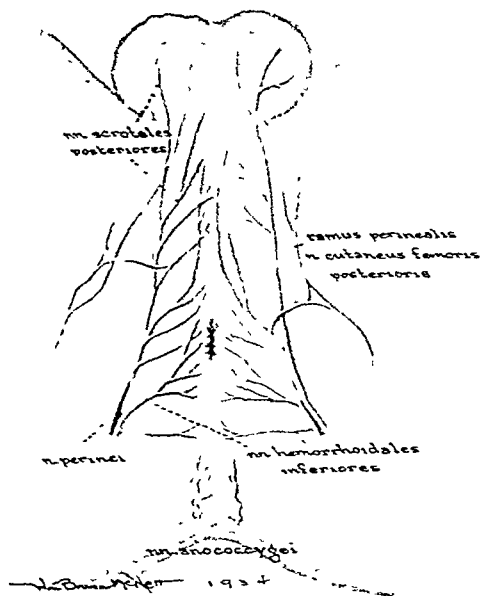


Fig 6 Distribution and location of sensory nerves of the anal region

ments with the perineal branch of the posterior femoral cutaneous and its muscular branch to the superficial transverse perineal muscle.

The anterolateral injections obtund the terminal branches of the perineal nerve, the muscular branches of the dorsal nerve to the penis or clitoris, and the more anterior branch filaments of the inferior hemorrhoidal nerve.

CONCLUSION

In our hands this method has proved of utmost value and is to be highly recommended in all cases in which local analgesia is indicated. There is no pain, distortion, or bulging and complete muscular relaxation is obtained. The method is simple in the extreme, requiring only careful adherence to technique.

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Fig 1 a An intradermal wheal is raised in the midline behind the posterior aspect of the anus

Step 6 With the finger in the anal canal as a guide, a $2\frac{1}{2}$ inch, 22 gauge needle is introduced through this wheal and gently advanced parallel to the anal canal for a distance of 1 to $1\frac{1}{2}$ inches. At this site, 5 cubic centimeters of the solution are very slowly deposited. The needle is with drawn up to, but not through the wheal.

Steps 7 and 8 are similar to Steps 3 and 4 the needle being inserted first on one side then on the other, deeply, backward, and forward toward the levator muscle for a distance of $2\frac{1}{2}$ inches. In each area, 5 cubic centimeters of the solution are injected. This completes the analgesia.

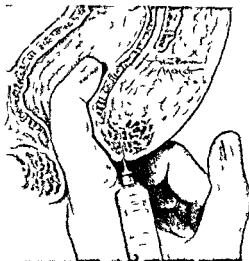


Fig 2 Sagittal section showing needle inserted in the posterior midline with finger in lower rectum as a guide

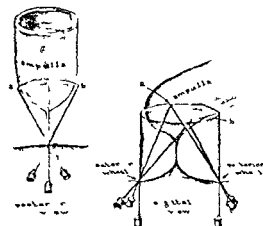


Fig 3 Posterior and sagittal view of the needles in relation to the anorectal area



Fig 4 Appearance of the needles and their direction were they left in place following injection. 1 and 4 needles parallel to anal canal posteriorly and anteriorly. 2 and 5 posterolateral injections. 3 and 6 anterolateral injections.

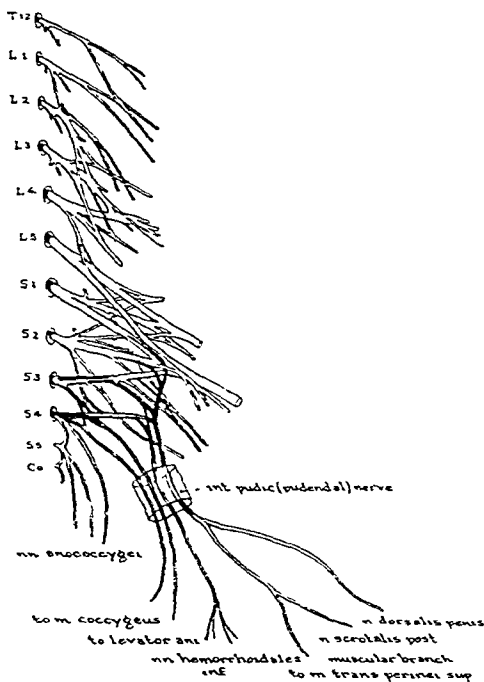


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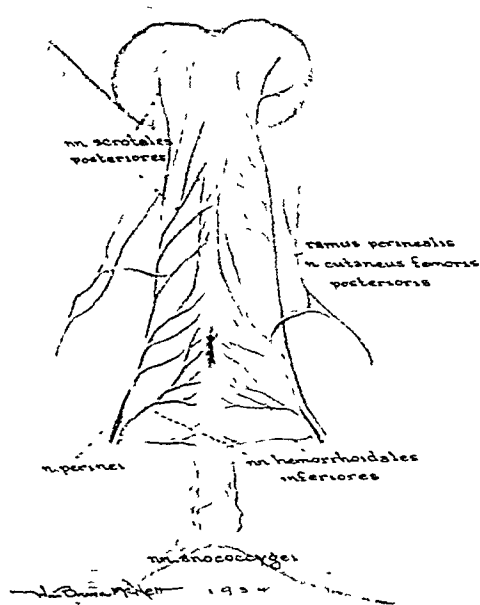


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THE TREATMENT OF FISTULAS OF THE SMALL INTESTINE

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THE occurrence of a fistula of the small intestine in an abdominal wound is a distressing complication. The seriousness of such a fistula depends upon its situation in the intestinal tract. The higher the location the greater the menace it constitutes to the life of the patient.

A high small intestinal fistula may have a rapidly deleterious effect upon the general health. In certain cases practically everything taken by mouth is almost immediately expelled through the fistula with the result that speedy malnutrition occurs. More important than the loss of food is the enormous loss of fluid containing gastric and pancreatic juice, bile and intestinal secretion. This means a loss of the sodium and chloride ions so necessary in maintaining the fluid volume of the tissues. This results in prompt and severe dehydration and serious changes in the acid base balance of the blood plasma (14). There occurs a rise in the blood nitrogen and a drop in the blood chlorides so that early treatment is required or death soon follows. The loss of bile and intestinal secretion further depletes the body fluids but the continued loss of pancreatic juice has been shown to be fatal (13, 41). The situation as has been shown by Morton and Pearse closely resembles that found in instances of high intestinal obstruction when the loss of food fluid, and secretions is by vomiting instead of by way of a fistula.

In addition to the effect of a high small intestinal fistula upon the general condition of a patient there is a local effect of the intestinal content upon the tissues as it exudes through the wound. This material is rich in enzymes and di-

gests the tissues of the abdominal wall, often dissecting under the skin or fascia many inches to either side of the wound. As the secretions pour out upon the abdomen they also attack the skin causing widespread and painful excoriations. Secondary infection often results. The patient becomes rapidly toxic, and added to this physical suffering there is the additional burden of mental anguish as the patient realizes that some serious complication has occurred.

The treatment of small intestinal fistulas has been reviewed by Ochsner (27) and by McElyer. It is most important that the general condition of the patient be constantly watched. Active supportive measures should be started immediately. The fluid loss must be made up. This is best accomplished by the administration of large quantities of intravenous fluid. A 5 per cent glucose solution intravenously from 2 to 6 liters daily may be necessary to keep the blood nitrogen within normal limits. The blood chlorides should not be allowed to drop below 400 milligrams. This necessitates the daily administration of salt solution which is best given as normal saline intravenously or subcutaneously. If the patient is greatly dehydrated a fair amount may be absorbed by proctoclysis which should be given slowly as a Murphy drip. Blood transfusions may also be of benefit. With constant attention to these important features in the patient's care the problem of the treatment of the fistula itself must be dealt with.

If the fistula is small the use of the prone position on an anterior Bradford frame as suggested by Potter (33) may aid in preventing digestion of the skin. Many substances have been applied to the skin as a protection against this local irritation and among the more widely used are

various ointments and powders Zinc oxide is the most frequently used Lorch uses destin ointment combined with intensive irradiation Smith and Christensen use kaolin and glycerin The more extensively used powders are copper bronzing powder advocated by Cunningham Many substances have been used to inactivate or neutralize the irritating qualities of the discharge Egg albumen locally and by mouth has been used by Ochsner (28) Dried milk has been used by Rees and others Potter (32) applies one tenth normal hydrochloric acid to the skin, and inserts a tampon saturated with beef broth into the fistula Warshaw and Hoffman, Fox (12), and others report favorably upon the use of Potter's (32) method, some using peptone instead of beef broth

Patel and Carcassonne report the cure of one serious case by oral administration of fractional doses of 12 grams of calcium chloride per day. In addition, 10 units of insulin were given daily These authors do not discuss the theory of this treatment However, it is probably based upon supposed inhibitory effect of large doses of calcium upon motor and secretory activity of the gastro-intestinal tract (4) Dietary restrictions are of little benefit. Continuous aspiration of the secretion by means of a catheter has been successfully employed by Erdman, Cameron, Cheever, Lahey, Walters and Kilgore, Walters and Bollman, and Ochsner The use of two catheters, one in the efferent and one in the afferent loop so that the intestinal contents are redirected into the bowel, has been employed by Wilkie Volkman and Peet favor this method

The artificial closure of the fistula by various means has been tried by many authors The use of Beck's paste as described by Baker is an excellent method if the fistulous tract is over an inch in length and not of too great a diameter Judd and Phillips have used chewing gum Plugging the fistula with gauze soaked in oil has been advocated by Rigby, Hendon, Stadler, and Fechen Johnston describes a method of temporary closure of a fistulous opening consisting of a two way catheter, the openings of which are connected with two small balloons, one at the end and the second situated about 15 centimeters proximally The inner balloon is introduced into the lumen of the bowel and is then inflated with a small amount of air, an amount just sufficient to allow it to be pulled easily into the fistulous tract but not out of it The outer balloon is then inflated so that the whole balloon lies wholly upon the abdominal wall, thus holding the inner balloon firmly in place and sealing the fistulous opening

There is another method of dealing with a high small intestinal fistula which, though not always feasible, may often prove a life saving measure. This is the artificial closure of the opening by means of a button or small plaque inserted into the lumen of the gut and pulled back against the opening by means of a suture which is allowed to emerge through the fistula Though not always practical, this procedure is well worth a trial. Pamperl reports the case of Reybard, who over a hundred years ago advocated the closing of an abdominal wound which penetrated through the wall of the intestine by inserting a wooden button into the lumen of the gut The button was then pulled back snugly against the opening with a suture which passed out through the skin wound and was fastened to a crossbar lying on the surface of the abdomen Kleybolte, in 1842, described a similar device made of leather Another method of artificial closure is by the use of a T tube as first advocated by Kappis in 1911. He inserted the horizontal portion into the lumen of the bowel and allowed the vertical portion to protrude through the abdominal fistula Eliot has used this method. Kaehler and Pamperl have used a rubber tube split in half. Ahrens believes that the T tube is preferable as it tends to depress the mesenteric wall of the bowel where often there is a tendency to spur formation at the junction of the efferent and afferent loops Dowd in 1917 describes a small disc which he inserted into the lumen of the bowel and held against the opening with a suture which passed through a small obturator, or hollow axle-like shank of the right length and was tied to a second disc on the skin C. H. Mayo (24) in the same year used the Dowd button Cattell reports the successful use of this button in several cases C. W. Mayo (25) used a bakelite button in the closure of a gastrostomy opening The success of these various devices depends upon having a relatively small opening in the bowel with moderately firm tissue about the opening against which the button may be pulled. If the hole is large, involving one-half of the circumference of the bowel for instance, or if it is situated at an angulation, such a button will not stay in place. A T tube in this instance is also of little value. With a large opening the liquid bowel content leaks about the tube and the pressure of the tube against the friable inflamed bowel wall causes further necrosis

Surgical procedures at this time are fraught with serious dangers and with small chance of cure The bowel may be visible but the walls are usually so inflamed that any attempt to free the margins and close the opening by suture results

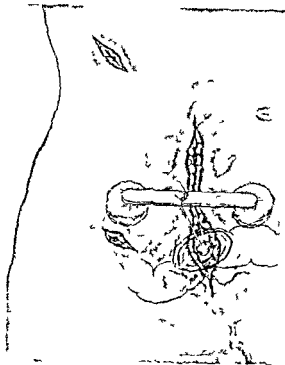


Fig. 1 Case 1 Condition of the abdominal wound at the time the rubber disc was first inserted. The opening in the bowel is visible in the lower angle of the wound. The rubber disc is shown in the outline held in place within the lumen of the bowel by a suture which emerges through the opening and is tied to a crossbar on the surface of the abdomen. There is a marked excoriation of the skin. The two counter incisions are shown one below the right costal border and one in the right groin. The intestinal drainage had dissected under the skin to these areas and abscesses had formed.

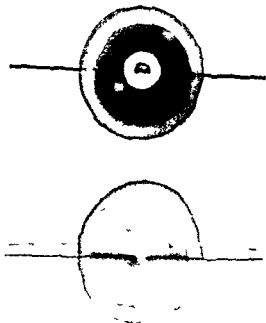


Fig. 2 The rubber disc which was used in Case 1

in the tearing of the bowel and increasing the size of the fistula. If the abdomen is opened with the idea of excising the fistula and doing an anastomosis or an enterostomy, there is the serious possibility of contamination with resulting peritonitis. Many operative procedures have been suggested, but any radical surgery is obviously contra indicated except when there is an obstruction lower down in the efferent segment. Rokhkind lists a second exception, namely when the defect in the intestinal wall is so large that the entire content is lost externally.

If there is any possibility of an obstruction in the efferent loop its presence should be determined at the earliest possible moment. Such an obstruction may be responsible for the appearance of a fistula in the first place. The wall of the exposed loop of bowel in an open infected wound is

much more likely to give way if there is an obstruction distal to it than if the bowel lumen is patent. Therefore if an obstruction is suspected it is well to insert a catheter through the fistula and into the efferent loop and inject an ounce or two of mineral oil. This will appear rectally if there is no obstruction. If the oil does not appear immediate operation for the relief of the obstruction is imperative as any attempt at closure of the fistula either by artificial or surgical means is futile. It may be possible to locate the exact site of the obstruction by injecting a small amount of barium into the efferent loop and following its course with the x ray. The longer the delay the greater the certainty of a fatal outcome. However if it could be determined that the obstructed area was situated well away from the fistula, it might prove more practical to make the incision directly over the obstructed area do an entero-anastomosis about it and rely on artificial closure of the fistula. Then as the general condition of the patient improved this could be closed later if it did not close itself.

So much for the necessity of immediate surgical interference. Now to consider the small intestinal fistula with an opening so large that the entire

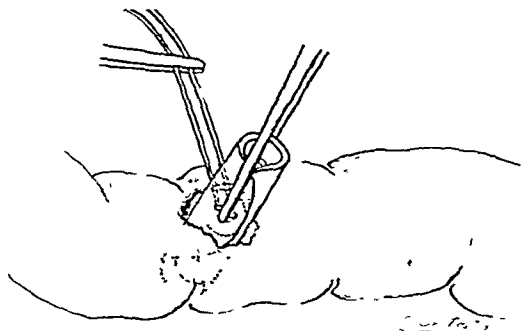


Fig 3 The rubber disc has been rolled up and it is being inserted into the lumen of the bowel.

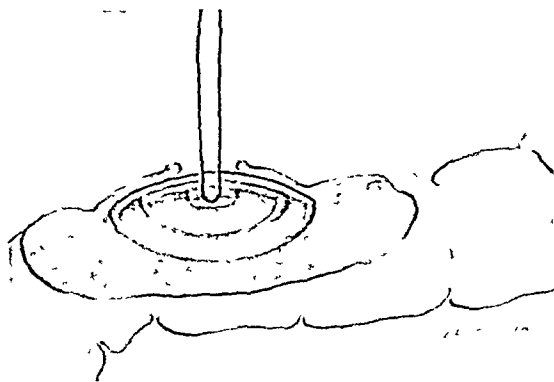


Fig 4 A sagittal section showing rubber disc inside the lumen of the bowel and pulled against opening by a suture which passes out through the fistula

content of the afferent loop is lost externally. We have devised a refinement of the button and tube method of artificial closure which may work where these may not. Let us consider such a fistula situated at a knuckle and involving about half the circumference of the bowel with a gaping and infected wound from which the intestinal contents flow in an almost uninterrupted stream. First we introduce a probe into the bowel to determine the approximate size of the lumen and the angle at which the afferent and the efferent loops meet at the opening. We then mold a wax model of the proper size and proper angle and with sufficient belly to receive the intestinal content from the efferent loop and shunt it around the corner into the afferent loop. This mold must be long enough to extend well beyond the area of the necrotic bowel. The general shape may be that of a half tube or an angulated tube from which a longitudinal strip, the width of a quarter to a half of the circumference, has been cut away. This wax model is then cast in pliable rubber which is easily folded up and inserted into the bowel but is stiff enough to return to and maintain its original shape. Into the exposed portion we place a heavy silk suture which is allowed to emerge through the fistula and is fastened to a crossbar on the surface of the abdomen. If the rubber cast does not stay in place, two sutures, one through either end and brought out through the bowel wall and abdominal wall will hold it there. The wound is then approximated with one or two large sutures or possibly a strip of adhesive tape. The leakage stops, the intestinal content is diverted into the bowel below the fistula. The general condition of the patient improves. The wound rapidly loses its angry appearance. With a little ointment on the skin and irrigation of the

wound, granulations soon appear and bridge across. After a short time the condition of the tissues may be so improved as to warrant surgical closure of the opening. Or if the opening is closing and becoming smaller, this cast may be withdrawn and replaced with a smaller one. When the granulations grow snugly about the thread, the latter may be cut, the button passes, and the fistula soon seals itself and heals completely. We feel this to be an improvement in the treatment of high intestinal fistulas as compared to early and more radical procedures.

SUMMARY

The treatment of small intestinal fistulas has been reviewed.

The presence of an obstruction distal to the site of a fistula constitutes the one all important reason for immediate surgical interference.

The practicability of closure of a small intestinal fistula by artificial means is stressed.

In the presence of a large fistulous opening, where other types of artificial (button) closure are unsatisfactory, the use of the rubber cast as described here, may prove a life saving measure.

Four cases are reported.

CASE 1 A male, 39 years old, was operated upon for sub-acute appendicitis. The operation was easily performed through a right rectus incision. An intestinal obstruction occurred. The patient was again operated upon on the fifth postoperative day. The obstruction was found to be due to an old fibrous band which constricted the small bowel at the level of the lower jejunum. This band was cut and the bowel freed. Just proximal to the band was a necrotic area which perforated spontaneously. The margins of this opening could not be approximated. An entero-anastomosis was made between this portion of the bowel and an empty loop distal to it. The anastomosis worked very well. Four other smaller perforations occurred in the distended necrotic bowel above the anastomosis. It was possible to close



Fig 5

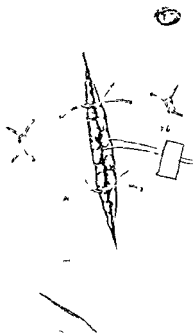


Fig 8

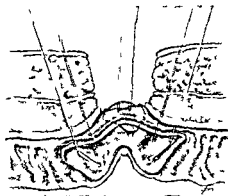


Fig 6

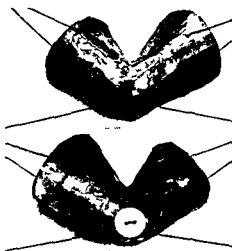


Fig 7

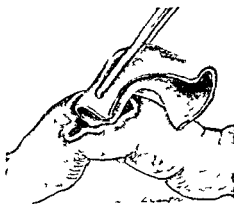


Fig 9

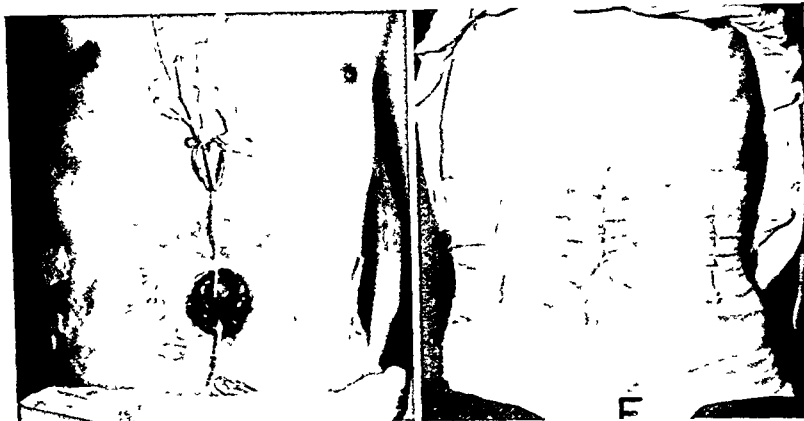


Fig. 10

Fig. 14



Fig. 11

Fig. 12

Fig. 13

Fig 5 Case 2 Condition of the abdominal wound at the time the rubber cast was first inserted. A knuckle of bowel is visible in the base of the wound. The top of this knuckle has sloughed off leaving a large hole. There is marked excoriation of the skin. The rubber cast is shown in place within the lumen of the bowel, held in place by a suture through either end which passes out through the bowel wall and the abdominal wall. There is a third suture fastened to the cast at the knuckle. This emerges through the fistula. This suture was later tied to a crossbar on the surface of the abdomen.

Fig 6 Sagittal section showing the rubber cast inside the lumen of the bowel. The sutures through either end of the cast pass out through the bowel wall and abdominal wall, and are tied on the skin. The central suture emerges through the fistula and is tied to a crossbar on the surface of the abdomen.

Fig 7 Two views of the rubber cast used in Case 2

Fig 8 The insertion of the rubber cast into the lumen of the bowel.

Fig 9 Case 2 Condition of the abdominal wound after the cast had been in place 1 week. There is no leakage and the condition of the wound is greatly improved.

Fig 10 Case 3. Condition of wound when patient came to the hospital after wearing a rubber button for over 8 months. He took care of this himself, and this shows his own method of fastening it in place.

Fig 11 Case 3 Button has been withdrawn, and the skin of the abdomen has been immediately flooded with intestinal contents.

Fig 12 Case 3 Button being inserted into the lumen of the bowel.

Fig 13 Case 3 The button is within the lumen of the bowel and is held in place by the attached string.

Fig 14 Case 3 Appearance of the abdominal wound 3 weeks after operation.

all these except one. The tissue about this was so friable that it was impossible to approximate the margins. A soft catheter was inserted through this hole into the lumen of the bowel, and brought out through the omentum which was tucked over this whole portion of discolored inflamed bowel. This catheter was brought out through the wound as an enterostomy. The enterostomy tube worked well. The wound became infected with colon bacilli which neces-

sitated the removal of several stitches, and on the sixth day a fecal fistula occurred. The opening in the bowel could be seen in the lower angle of the incision (Fig 17). Food and fluids came through this opening within 5 minutes after being taken by mouth. The wound infection progressed. There was a copious amount of intestinal drainage pouring from this opening in a nearly constant stream. This material was very irritating. It excoriated the skin and dissected



Fig 15



Fig 16



Fig 17

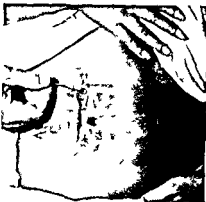


Fig 18

Fig 15 Case 4 The soft rubber button is in place within the lumen of the bowel. It is pulled back against the opening by means of a black silk thread which emerges through the upper angle of the wound.

Fig 16 Case 4 The wound strapped and thread held by a strip of adhesive tape above the upper angle.

Fig 17 Case 4 The tension has been removed from the thread and the wound and drapes have been flooded with intestinal content.

Fig 18 Case 4 Appearance of the wound 3 weeks after insertion of the button. It is well healed except for a small granulating sinus at the upper angle through which the thread emerges. Three days after this picture was taken the thread was cut. The wound was healed within a week.

under it to either side of the wound. A tender mass appeared below the right costal border and a second in the right inguinal region. These were incised and drained. They proved to be abscesses and were connected with the wound.

The patient lost ground rapidly. The blood nitrogen mounted. The enterostomy tube stopped draining and was removed. Many different ways of dressing the wound were tried but the drainage was so copious that the surface of the abdomen was almost constantly flooded with this irritating intestinal content. Finally a soft rubber button was devised out of two layers of rubber tissue (Fig 2). This disc or button was then rolled up and inserted into the lumen of the gut (Fig 3) and pulled back against the opening in the bowel (Fig 4) by means of a suture which was allowed to emerge through the incision and was fastened to a cross bar on the surface of the abdomen (Fig 5). The

drainage of intestinal content stopped immediately. The patient's general condition rapidly improved. The wound infection cleared up. Healthy granulation tissue soon grew firmly about the thread. Six weeks after the insertion of this rubber disc the suture was cut and the button passed. The fistula had sealed itself. One week later the patient was without a dressing.

CASE 2 A male 42 years of age was operated upon by a colleague for chronic appendicitis and to free abdominal adhesions. On the tenth day a wound infection developed. The wound was probed—gas and fecal matter escaped. He was first seen in consultation 2 weeks after the operation. The fistula had been discharging for 4 days. There was a large gaping infected wound with marked excoriation of the skin. The opening in the bowel which was visible was large and situated at an angulation. All foods and fluids taken by mouth were soon lost through the fistula. The ordinary

type of button would not stay in place. A rubber cast was made from a wax model as previously described (Fig. 7) and inserted into the bowel (Fig. 9). A suture was first placed through the angle or knuckle of the rubber cast to hold it. This was at first anchored to the skin with a tab of adhesive tape (Fig. 8). It was later tied to a crossbar in order to pull the cast more snugly against the opening in the bowel. Two more sutures were then placed in the cast, one through either end (Fig. 7). These were brought out through the bowel wall and abdominal wall (Figs. 5 and 6) and tied in place (Fig. 8). The wound was loosely approximated. There was only a slight amount of leakage thereafter. The general condition of the patient improved. The condition of the wound improved so much that a simple secondary closure was performed 2 weeks later. This was successful and the patient was able to leave the hospital on the fifteenth day.

CASE 3. A male, 17 years of age, was shot through the body with a No. 22 rifle. The bullet entered just to the left of the twelfth thoracic vertebra, passed through the pleural cavity, perforating the lower lobe of the lung, diaphragm, liver and stomach, and emerged through the fifth interspace in the left nipple line. An abdominal exploration was performed a few hours later and the stomach perforations were sutured. The postoperative course was stormy, with fever, 102 degrees and distention of the abdomen. On the eighth day the patient suffered a severe hemorrhage from the stomach necessitating a transfusion. On the tenth postoperative day the wound opened up and was resutured. Five days later a fecal fistula appeared, and patient was put on a Bradford frame. At the end of the third week he developed an empyema of the left thoracic cavity. Closed drainage was instituted. In the fourth week an appendiceal abscess was discovered and drained. All this while the fistula was draining copiously. I first saw the patient in consultation with regard to the fistula, approximately 1 month after his accident. At that time he had a large fecal fistula in an upper abdominal wound. His weight had dropped from 108 pounds to approximately 50 or 60 pounds, and he was in a truly pitiful condition. Ointments, powders, suction, in fact a long list of things had been tried with little or no success. The mucous membrane had grown to the skin as in a permanent colostomy (Fig. 10). The opening was about the size of a half dollar. A rubber cast was made and inserted. From that day the general condition of the patient gradually improved. During the course of the next month 3 operations were performed. The right lower quadrant was explored, a rib resection was done, and open drainage of the empyema was instituted. Also, a left subdiaphragmatic abscess was drained. Four months after the accident the patient was able to leave the hospital. By this time he had worn the button for 3 months and was looking after it himself. Sometime later he made one for himself out of an inner tube. He wore this button until June, 1937. He was able to ride a bicycle and play golf. His general condition improved so much that early in June the incision was opened. The fistulous opening was excised together with about 3 inches of bowel proximal and distal to the opening. An end-to-end anastomosis was performed and the patient was able to leave the hospital with a healed wound in about 2 weeks. This case affords an excellent example of the value of this rubber button type of closure. It was worn continuously for over 8 months, during which time the patient underwent three serious major operations. He recovered and gained in general strength sufficiently so that he was able to go home and lead a fairly normal and comfortable existence until his general health had improved to such an extent as to permit him to withstand a resection of his bowel.

CASE 4. A colored female, aged 29 years, was admitted to the hospital with a strangulated umbilical hernia, with a two day history of abdominal pain, emesis, and fever. The white blood count was 14,700, and the polymorphonuclear count was 92 per cent. An operation was performed within a few hours. A small incision was made over the mass just above the umbilicus. A small loop of jejunum was found incarcerated in a sac. It appeared black but was thought to be viable. It was dropped back and the hernia repaired. The postoperative course was stormy—fever, 101 to 103.6 degrees, pulse, 100 to 140, marked abdominal distention partially relieved by Wangenstein suction. A bronchopneumonia and pleurisy developed. The general condition improved slightly. On the tenth postoperative day the pulse was still elevated, and the abdomen still distended. On the twelfth postoperative day, a fecal fistula appeared in the wound. This drained more copious amounts each day. The patient was given 3000 to 4000 cubic centimeters of intravenous glucose and saline daily. However, 1 week later, in spite of this intensive treatment, the blood urea was 121.7 milligrams per cent and the blood chloride was 346.5 milligrams per cent. She was seen in consultation on this same day. The wound was open, the fistula visible in the base of the wound. It was impossible to keep the wound dry, and there was much necrotic tissue along the margins of the wound. Several times in the course of inspection of the wound, 100 to 200 cubic centimeters of intestinal content gushed out, flooded the abdomen, and ran into the bed. The fistula was about 1 centimeter in diameter. It was explored with the finger and found to arise from a slightly constricted portion of the bowel. The bowel for a distance of about 2 centimeters to either side of the fistula felt firm and indurated. Beyond that it seemed to be normal. A soft rubber button was made similar to the one devised for Case 1. It was rolled up and inserted into the lumen of the bowel, and pulled back by means of the attached thread which was fastened to the skin. The patient's condition remained about the same for 2 days. The temperature and pulse remained elevated, temperature, 101 to 104 degrees, pulse, 110 to 120. A continuous intravenous infusion was started, and within 2 days she appeared much improved. The temperature and pulse levelled off to normal, and in 3 days the blood urea had dropped from 121.7 milligrams per cent to 49.2 milligrams per cent, and the chlorides had risen from 346.5 milligrams per cent to 412.5 milligrams per cent. The wound rapidly cleared up. The button came out two or three times in the first 48 hours. After that it remained in place, and there was no leakage. The wound margins were approximated with adhesive tape and a cod liver oil and vaseline dressing was applied. Three weeks from the time the button was introduced, the wound was healed except for a small sinus through which the thread passed out and was fastened to the skin of the abdomen. The patient was up and about. At this point the thread was cut, the button passed, and the patient was completely healed within a week.

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Fig 15



Fig 16



Fig 17



Fig 18

Fig 15 Case 4 The soft rubber button is in place within the lumen of the bowel. It is pulled back against the opening by means of a black silk thread which emerges through the upper angle of the wound.

Fig 16 Case 4 The wound strapped and thread held by a strip of adhesive tape above the upper angle.

Fig 17 Case 4 The tension has been removed from the thread and the wound and drapes have been flooded with intestinal content.

Fig 18 Case 4 Appearance of the wound 3 weeks after insertion of the button. It is well healed except for a small granulating sinus at the upper angle through which the thread emerges. Three days after this picture was taken the thread was cut. The wound was healed within a week.

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UTERUS BICORNIS DUPLEX ASSOCIATED WITH INFECTION DUE TO MICRO-AEROPHILIC HEMOLYTIC STREPTOCOCCUS

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CONGENITAL malformations of the uterus have been classified in various ways by different authors. The following grouping, suggested by Strassmann, appears to be the most satisfactory:

1. Uterus septus—the septum extends through the body of the uterus and the cervix. It may or may not pass down to divide the vagina in half.

2. Uterus subseptus—the septum is incomplete.

3. Uterus bicornis—a uterine horn is free on both sides. Depending upon the degree of separation and non-union of the horns there result here the following subgroups:

a. Uterus arcuatus—there is simply a slight indentation or notch in the fundus, resulting in a heart-shaped uterus.

b. Uterus bicornis unicollis—the indentation further separates the two horns, they being joined at a point only a short distance above a single cervix.

c. Uterus bicornis duplex—the horns are further separated, but the adjacent walls are fused just above the cervical level. There are two distinct cervixes and there may or may not be two vaginas.

d. Uterus didelphys—there is complete separation of the horns with formation of a true double uterus. There are two cervixes and two vaginas. This anomaly is the rarest of all.

No attempt will be made here to discuss the embryology of the uterus in detail. Suffice it to say that most uterine malformations are the result of improper fusion of the two müllerian ducts, resulting in an accentuation of what are called horns in the adult uterus. Many theories have been advanced to explain the factors responsible for this failure of fusion of the ducts, and among them the following seem most worthy of mention. In the case of many of the theories, the proponents have failed to advance tangible evidence in support of their ideas.

1. Prominence of a rectovesical ligament. This ligament is frequently found between the two

horns of a normal single uterus, and between those of a bicornate uterus. However, this ligament might just as well be a part of the anomalous condition itself as its cause.

2. Fetal peritonitis, the resulting adhesions preventing fusion of the ducts. This course of events must be exceedingly rare, if indeed it occurs at all.

3. Abnormal persistence of a cloaca, or

4. Disturbance of development of the intestinal tract or bladder, the abnormalities thus preventing normal union of the two ducts.

5. Too short round ligaments, or

6. A broadening (widening) of the bony pelvis, again preventing proper fusion.

7. Variations in the germ plasma itself.

It is probable that one or more of these factors play a part, varying in different instances.

Congenital malformations of the uterus are not rare, but relatively few cases are recognized during life. Statistics as to their frequency are confusing because the exact nature of the anomaly is not always accurately described by the author, and there is often disagreement as to which name should be applied to the particular anomaly in question. Various statements occur in the literature concerning the frequency of the rarest anomaly, i.e. uterus didelphys. Findley quotes Stolper as having found 10 cases in 7,400 married women, and Neugebauer as finding 3 cases in 19,000 examinations, but whether the observations were made clinically or postmortem is not stated. Findley himself was able to collect from the literature 135 true cases of uterus didelphys up to 1926. With regard to the more common bicornate uteri, Falls says "the frequency is estimated to be 1 per cent," but gives no statistical proof of his statement.

As a rule doubling of the uterus does not assume clinical significance until the advent of pregnancy, and even at such a time the condition is frequently unrecognized. Many amusing reports occur in the literature concerning the confusion which has resulted from failure to recognize the abnormality. In breech presentations, when the septum is incomplete, one leg may pass down one side, the other leg down the other side, and the

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Patient was entirely well until 2½ years ago at which time she was suddenly seized with a sharp pain running from the lower lumbar spine to the right hip. This pain remained constant, did not radiate in any particular direction, was not associated with nausea, vomiting, change of bowel habits, genito-urinary or gynecological symptoms. The pain was at first severe enough to keep her home from work and to prevent sleep. There was no preceding history of trauma. After 3 days of treatment with hot water bags, the pain disappeared. After that she had similar attacks of pain, occurring several times a year, but between the attacks she remained quite well. A severe attack 9 months before admission was diagnosed as acute appendicitis. Operation was advised but refused and the pain gradually subsided. Fifteen weeks before admission the patient was seized with a similar attack of pain. The surgeon advised immediate operation, which was performed in the hospital in North Adams, Massachusetts. An abscess was found in the right lower quadrant of the abdomen and right side of the pelvis. The surrounding tissues were acutely inflamed and glued together with fibrinous exudate. The surgeon was not sure whether the appendix or the right tube was the primary focus of infection, and he decided to drain the abscess. A culture of the pus was reported to yield a hemolytic streptococcus. The wound continued to drain and the fever was maintained. Five weeks later the wound was reopened and another large abscess was found and drained. But this abscess likewise continued to drain profusely, and the patient suffered much pain. Her fever continued, her appetite failed, she lost weight and strength, and developed pressure sores on her back. Finally the region of the right hip became swollen and the right thigh tender and painful. She was seen in consultation by one of us (F.L.M.) in the North Adams Hospital. It was obvious that the infection had spread extensively and required further drainage. The doctors in charge of the case advised transferring the patient to New York for the purpose of further treatment. Although it was recognized that the risk of transportation was great, it seemed best to make the change. The trip of 180 miles was very tiring.

On arrival the patient was pale and emaciated and evidently in considerable pain and discomfort. The temperature was 101.6 degrees and the pulse was rapid. The eyes, ears, and nose were essentially negative. The mouth was dry; the tongue coated, the throat was normal. No enlarged glands were felt in the neck. The lungs were clear. The muscular tone of the heart was feeble, and there was a systolic murmur over the pulmonic area. The abdomen was moderately distended and everywhere tender. In the lower abdomen to the right of the midline was an ulcerated area with undermined margins. In the depths of the ulcer, a sinus led through the abdominal wall down toward the right lower quadrant. From it large quantities of pus were discharging (Fig 1). The right lower quadrant above Poupart's ligament was bulging and there was a large area of fluctuation just beneath the skin. The upper third of the right thigh was swollen and edematous with fluctuation over Scarpa's triangle. Pressure here caused pus to pour forth from the abdominal sinus. The posterior surface of the thigh also revealed deep fluctuation. The hip joint, however, could be moved without great pain. The right leg as well as the whole left lower extremity showed considerable wasting.

The patient was obviously too sick to stand an immediate operative procedure. She was given fluids and a sedative. The white blood count was 11,700, with 65 per cent polymorphonuclear leucocytes. The urinalysis was negative. On the day after admission the patient seemed

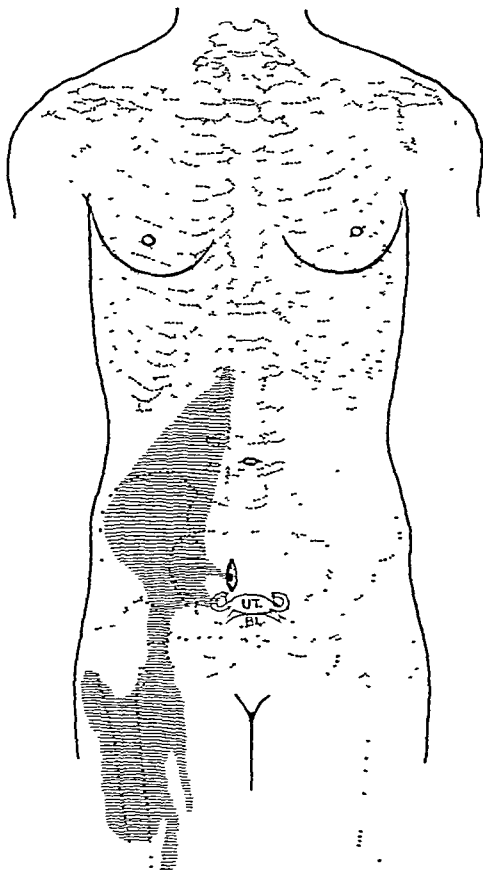


Fig 3 Extent of abscesses as seen at operation

a little better and stereoscopic films of the pelvis and right thigh were made before and after the injection of lipiodal into the abdominal sinus. The report follows: "The oil puddled along the psoas margins retroperitoneally, and the tip of the catheter extended as far as the first lumbar level. There is an obvious cavity with gas in it, lying in the anterior thigh region, and it is reasonable to suppose that the two cavities communicate. There is no evidence of bone pathology. The hip joint is not unusual" (Fig 2).

On the third day the patient was very uncomfortable and cried whenever she was touched or moved, but her general condition was slightly improved. It seemed best not to delay the operation. Long incisions were made on the anterior and posterior aspects of the thigh and large quantities of pus were released from a cavity surrounding the upper third of the femur. This cavity extended upward along the iliopsoas muscle into the retroperitoneal space where a large mass of necrotic tissue lay in a huge abscess cavity. This abscess was drained through an oblique incision above Poupart's ligament (Fig 3). The whole infected area was flooded with a suspension of zinc peroxide in distilled water. The wounds were lightly packed with gauze soaked in this suspension and the dressing was sealed with vaseline gauze.

Culture of the pus obtained at operation showed a microaerophilic hemolytic streptococcus, an anaerobic non-



Fig 1 Appearance of ulcer of abdominal wall upon admission

baby thus straddles the septum. Cases of superfetation are reported (22), one woman giving birth to a 7 months' infant followed 3 days later by a fetus approximately 3 months in age. Confusion in diagnosis has resulted from the fact that one condition may be noted by the first observer on one side of the vaginal septum, while a consultant, who examines the other cervix, is unable to corroborate his colleague's impression. Diagnoses have been made of ovarian cysts, myomas, or even ectopic pregnancies. Women with double uteri conceive readily 40 per cent, however have complicated deliveries (21) and abortion and premature labor occur frequently, 17 per cent develop retention complications. There is unusual fertility in some cases. In one instance (21) there were delivered 1 baby in the first pregnancy, 2 in the second, 3 in the third, 4 in the fourth and 3 in the fifth, making a total of thirteen babies in five pregnancies! In the last labor the uterus ruptured.

Of the lesions associated with double uterus hematometra is the most frequent. When it occurs on one side only, menstruation by the other uterus will confuse the diagnosis. As would be expected dysmenorrhea is a common symptom.

Other lesions which have occurred in association with double uterus are tumors of one cornua (polyps 2, fibroma 6, adenomyoma carcinoma 24, chorionepithelioma 8, hematocolpos salpingitis, 4, ovarian cysts tumor in an hemiatretic horn 32, ovarian abscess 4, inguinal hernia containing a horn of a bicornate uterus, 25, acute intestinal obstruction due to pregnancy in a bicornate uterus, 25, empyema of cervical cyst 12).



Fig 2 Roentgenogram showing gas filled abscess cavity in thigh

Several patients were operated upon with a diagnosis of acute appendicitis (17, 26).

Findley emphasizes the fact that absence of the right kidney and ureter is a frequent associated anomaly in this condition, and he suggests preliminary catheterization of the ureters before any operative procedures are done. In one instance in which hysterectomy was done, the only existing ureter was severed. In the case to be presented herewith one kidney was absent.

We have been able to find records of comparatively few cases however in which infection played a prominent part in the clinical picture. Several of these were gonococcal in origin (8), while 2 developed a streptococcus peritonitis (9, 29). In the case reported by Mihailenco a condition was found (pyocolpos and pyometros with retroperitoneal extension) which was very similar to the case to be presented.

The following case is reported as an interesting example of an uncommon uterine anomaly associated with infection due to a microaerophilic hemolytic streptococcus.

B. S. female age 24 years, Massachusetts textile mill worker, was admitted to Presbyterian Hospital, New York City, February 22, 1937. Unit history No. 511348. The family history was irrelevant. Patient had been married 8 years and had not been pregnant. Husband was living and well. Occupation—cotton spindle operator. She had had no previous illnesses or operations. Menstrual periods had

always been irregular, occurring every 14 to 21 days, always accompanied by severe dysmenorrhea; flow variable

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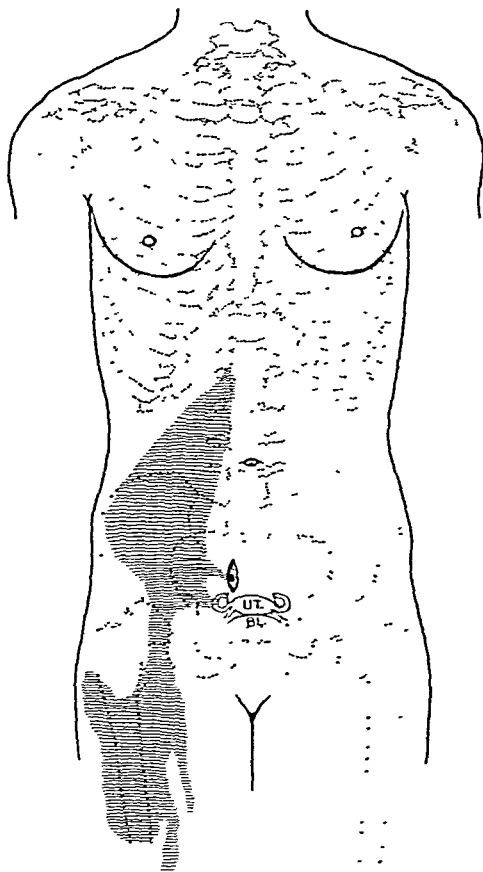


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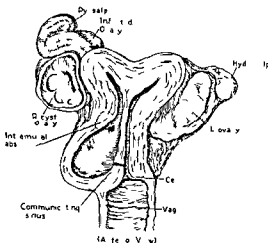


Fig. 4 Uterus bicornis duplex

hemolytic streptococcus, an aerobic green streptococcus, a hemolytic and a non hemolytic colon bacillus, and an anaerobic gram negative bacillus *Bacillus fusiformis* necrophorus. The patient's condition was poor following operation. The blood pressure fell to 80/40, but after an infusion rose to 110/58. The white blood count fell to 6,500. On the morning of the day after operation the temperature fell and the patient seemed better although the pulse remained rapid. On the second postoperative day the patient went into shock and became comatose, the blood pressure falling to 60/40. An attempt was made to restore her with infusions with cortin and with transfusion but the pulse gradually failed and she expired.

The necropsy (No. 12390) was performed 2 1/2 hours postmortem. The body was undernourished and poorly developed. There was a scar 12 centimeters long in the lower midline of the abdomen, its distal 8 centimeters gaping open to form an oval cavity 5 centimeters in width and 2 centimeters in depth. This cavity was lined with purplish red granulation tissue on which lay a fibrous exudate and gray coarsely granular powder (zinc peroxide) 1 cm from the base of the cavity a sinus tract 1.5 centimeters in diameter extended inward. Recent large gaping incisions were present on the anterior and posterior aspects of the right thigh and another in the right lower quadrant of the abdomen parallel to Poupart's ligament and to the right iliac crest. These wounds extended deeply and were continuous with large cavities that completely surrounded the upper right femur and passed upward over the iliopsoas muscle to communicate with the retroperitoneal abscess cavity (Fig. 3). The walls of the cavities were lined with infected granulation tissue.

The peritoneal cavity contained 1200 cubic centimeters of turbid grayish yellow fluid in which were suspended flecks of fibrin. The peritoneum was everywhere injected and fibrous exudate bound together loops of intestine. The inflammatory reaction appeared to be recent.

The other abnormal findings were limited to the genito-urinary system. The right kidney and ureter were absent. The left kidney was large, weighing 340 grams and measuring 15 by 7 by 4.5 centimeters. It was grossly and histologically normal. The bladder was normal except for the absence of the right ureteral orifice. Inflammation of the serosa was the only abnormality of the alimentary tract.

The uterus was large, measuring 8.5 centimeters in length, 6.4 centimeters in width, 2.5 centimeters in thickness. It was bicornate and its general appearance and relationships are shown in Figure 4. The cervix of the left uterus was normal except for the fact that its canal was 5 centimeters in length. There was no cervix on the right, the right uterine cavity terminating in a pear-shaped pouch 3.5 centimeters in its longest dimension. The inner surface of the pouch was smooth and glistening, its wall was found to be composed of dense fibrous tissue and smooth muscle covered by granulation tissue. In places were patches of endometrial tissue containing glands. The two uterine cavities communicated with each other by means of a passage 1 millimeter in diameter through the septum about 1 centimeter above the cervix. The cavities of the right uterus and of the blind vaginal pouch were filled with thick green pus, and a few drops of pus also were present in the left uterus where it had extended via the communicating passageway. The tissues about the right uterus were undurated and in two places small cavities budded off the right uterine cavity where extension of the infection had occurred. There was a pyosalpinx on the right and the right ovary was represented by several multiloculated cystic spaces, some of which contained pus. Communication between this infected ovary and the retroperitoneal abscess was demonstrated. There was a hydrosalpinx on the left and the left tube and ovary were abnormally located, the tube lying mainly behind the fundus, the ovary against the body of the uterus.

The appendix showed no evidence of having been the primary focus of the infection. Fibrous adhesions pulled its tip down into the pelvis so that it lay lateral to the end of the right fallopian tube.

The left uterus was lined with normal endometrium while the endometrium of the right one was atypical, there being fewer glands present and in places areas of stratified squamous epithelium. The right fallopian tube presented a picture of subacute inflammation.

A culture of the pus obtained at the first operation at the North Adams Hospital yielded a hemolytic streptococcus. It is not certain whether this organism was obtained on direct plating of the pus or whether it appeared more slowly on liquid media. However, with the history of prolonged drainage of a pelvic abscess yielding on culture a micro-aerophilic hemolytic streptococcus along with other intestinal organisms, it is reasonable to suppose that the hemolytic streptococci were the same. Either the organism was micro-aerophilic at the start or in the course of the prolonged infection it took on anaerobic properties.

Infections caused by the micro-aerophilic hemolytic streptococcus are characterized by prolonged suppuration with extensive burrowing. Although they are usually associated with infections of the skin and subcutaneous tissues producing chronic undermining ulcers, they also tend to burrow into the deeper tissues. In this case there was an undermining ulcer of the abdominal wall but the principal lesion resulted from the burrowing of the infection upward along the psoas muscle to the lumbar region and downward into the thigh. The

formation of gas in the tissues indicated the activity of one or more of the contaminating organisms, either the anaerobic non-hemolytic streptococcus, the colon bacillus, or the *Bacillus fusiformis necrophorus*. Infection also terminally spread into the peritoneal cavity proper. It is not certain whether that spread occurred at the time of the operation and as a result of it, or a short while before. No communication was found between the abscess cavity and the peritoneum but a tiny opening might have been made in spite of the great care that was taken to avoid it at the time of the operation. In a similar case reported elsewhere (18) death occurred from peritonitis when the peritoneum was opened in an attempt to eradicate the infection by excision.

It is important to consider how this organism entered the patient. It may have come through the blood stream, perhaps gaining entrance from the throat, or from the intestine by direct extension from adherent loops of gut, or from the appendix. A more likely portal of entry was the anomalous uterus, for the following reasons:

1. The organism is occasionally found in the normal vagina
2. Of 16 cases of infection with micro-aerophilic hemolytic streptococcus reported previously by one of us (F.L.M., 18, 19), 7 were pelvic infections in women, in whom the uterus and tubes were the probable portals of entry. The organism thus appears to have a predilection for the uterus and tubes
3. Assuming that the organism gained entrance through the vagina, it must have entered the left uterus and either have passed through the opening in the septum to the right side or have passed through the left tube into the pelvis and thence to the right side. The infection may have become established in the right "vaginal pouch" with subsequent spread to the right uterus, tube, and ovary, or it may have started first in the tube, with later extension to the ovary and uterus. The microscopic study showed the inflammatory changes in the tube to be of longer duration and greater severity than those in the uterus. It is likely that a long standing hematometra or hematocolpos served as a *locus minoris resistentiae* that favored the establishment of the infection.

It is probable that the infection could never have been eradicated in this case because of the nature of the congenital anomaly. Any attempt at removal of the infected uterus and tube from above would almost certainly have caused a fatal peritonitis. Drainage from below would have been ineffective. In either event it would have been impossible to obtain contact between the zinc peroxide and the deepest foci of the infection in the uterus and tube. It is possible that sulphanilamide might have had a beneficial effect on the hemolytic streptococcus if it had been used in the early stages of the disease, but it would have had no effect during the later stages when other organisms were present.

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EDITORIALS

SURGERY Gynecology and Obstetrics

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JANUARY 1938

IMMEDIATE VERSUS DELAYED SURGERY IN ACUTE CHOLECYSTITIS

THE surgical management of acute cholecystitis has long been a subject of discussion because of differing opinions regarding the advantages of immediate rather than delayed surgery in this condition. Years ago, surgical opinion was preponderantly in favor of delay in operating for acute cholecystitis until the active inflammatory process had subsided. In recent years, however, this viewpoint is definitely changing as shown in papers by Miller, Stone and Owings, Andrews, Heuer, and others, and an increasing number of surgeons are finding immediate cholecystectomy the treatment of choice in acute cholecystitis. Further evidence of the changing modern viewpoint was recently given in the editorial by Heyd in this *Journal*. Immediate operation in acute cholecystitis is the treatment of choice in my opinion, not only because clinical experiences with it have been good but also because it is

my belief that the pathological condition present makes early operation positively indicated.

Most students of the pathology of acute cholecystitis now agree that obstruction to the cystic duct is the primary lesion in this disease, and that infection, when it occurs in these cases, is a secondary phenomenon which is dependent on this obstruction for its development. Usually a stone causes the obstruction to the cystic duct. Following this obstruction, comes swelling of the gall bladder with resultant pressure on the veins and lymphatics that lie in close relation to the tortuous folds of the cystic duct. In some cases, branches of the cystic artery are occluded and infarction of parts of the gall bladder wall appear. Gangrene and even perforation may occur if the edema, infarction, and necrosis advance. The time necessary for these changes to appear after a stone is impacted in the cystic duct will vary with the completeness of the obstruction to the duct and with the anatomical arrangement of the blood vessels in the individual case.

Studies of the bacteriology of acute cholecystitis by Wilkie, Denton, Feinblatt, Andrews, and others have all shown that infection of the gall bladder is *not* the primary etiological factor in acute cholecystitis. Most workers agree with Feinblatt and with Denton that the rôle of infection as a cause of cholecystitis has been greatly overestimated. The recent studies by Andrews show that bacterial infection plays a very minor rôle in this disease. All recent students of the bacteriology of acute cholecystitis agree that metabolic, mechanical or circulatory changes must be present in the gall bladder before bacterial infection will occur.

Clinically, these findings are confirmed by the course of many cases of acute cholecystitis in which patients are operated upon within 48 hours of the onset of their pain. Such patients reveal at operation tensely distended, edematous, red gall bladders. Yet their course following immediate cholecystectomy is generally very much like the course of any laparotomy for a non-inflammatory lesion. In some respects the early case of acute cholecystitis resembles that of the early case of an ovarian cyst with a twisted pedicle. Basically, the pathology of the two conditions is an interference with the blood supply of an intraperitoneal viscus. In each case, therefore, immediate surgery is a logical procedure. In neither situation, certainly, is the fundamental pathology a "septic process."

A recent study of a series of cases of acute cholecystitis has impressed me with the advantages of the immediate over the delayed operation. By "immediate operation," I refer to operations, usually cholecystectomy, carried out within 2 to 3 days of the onset of pain. It is perhaps unnecessary to say that in every one of these cases there is always time to prepare for this surgery by the administration of fluids and glucose. In my experience, when operation has been done within 48 hours of the onset of the attack, complications are few, hospital stays are short, and there is no mortality. When the operation is performed late in the disease, complications due to infection are common, perforation is found in 14 per cent, hospital stays are long, and secondary operations are often necessary.

It is my belief that cystic duct obstruction is the first event in the pathological process of acute cholecystitis and that infection, when it is present, is secondary to cystic duct obstruction. Immediate removal of the gall bladder, therefore, in the early cases of acute cholecystitis seems indicated as soon as the

diagnosis is apparent and before infection, with its complications, has appeared.

HOWARD M. CLUTE.

CONCERNING THE TERM "SHOCK"

IT IS one of the common generalizations of economics that money of low value drives out of circulation that of higher value. Similarly in the use of words, those with a low content of precise meaning and therefore widely applicable, frequently displace those more accurate terms which are more limited in scope or at least impede the introduction of such. Some words have a specious appearance of precision and in that respect resemble counterfeit money, and one of these is the term "shock."

Defining a word serves the same purpose as assaying the metallic content of a coin and will frequently disclose the baseness of its content. In attempting to do this with "shock," it is soon discovered that it only represents a congeries of symptoms and signs which is characteristic of no one mechanism or etiological factor, without it be the condition of the observer's mind. It is in short one of those words "which cloak the unknown in the indefinable."

Yet the fact that it is in current and common usage signifies that it meets some demand—a demand which should be satisfied by a more cogent term.

In the early nineteenth century when "shock" began to be more intensively studied with the resulting popularization of the term, the concept was broadened by Romberg beyond the common idea that it was associated only with surgery, by indicating that it was in essence a failure of the circulation of the blood which occurred as a terminal phenomenon in many diseases including those caused by specific

infectious agents. Recently this same concept has been revived and given the horrific name of "medical shock," which distributes the disgrace of the term even more widely.

During these years, as the result of many investigations, it has come to be understood that failure of the circulation of the blood is usually due to either a deficient propulsive force—cardiac failure—or inadequacy of the distributive apparatus, that is to say, vascular failure. That the latter is most frequently due to a decrease of blood volume as a result of

the inability of the blood vessels to retain all or some of the components of its contents does not invalidate the significance of the term, vascular failure.

It would seem reasonable then to abandon the inexact and misleading word "shock" and replace it with *cardiac failure* or *vascular failure* depending upon whether the propulsive or the distributive mechanism is primarily involved. With either of these, the causative factor may be named so as to complete the picture.

SAMUEL C. HARVEY

FAMOUS AUTOGRAPHS

THREE DOCTOR WILLIAM BEAUMONT LETTERS

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MANY of the biographical sketches of Dr William Beaumont that have appeared from time to time and are still appearing, though interesting and stimulating, consist essentially of a reiteration—sometimes almost *verbatim*—of previous authors. The legend, and lore, and the facts concerning William Beaumont will bear repetition.

From the Physiological Laboratories, The University of Chicago

The interest taken in him and his accomplishments are highly commendable. This man, whose achievements merit canonization as the patron saint of American Medicine, has been sadly overlooked by the profession. He will always remain a model for bed-side solicitude, self-sacrifice, research in the clinic and laboratory, and accomplishment under trying conditions that required dogged persistence and the necessary drive to carry on in spite of the

Yes, Henry of this morning, was not?
& kindly appreciated - no appre-
ciable offences felt at the
course you have taken for
the rescue of your patients -

But your reason & sense
of propriety will excuse me
for declining your request
of associating my professional
character & reputation with
the infinitesimal part of
nothing - alies - Homoeopathy.

Quackery. Humbly &
by continuing my usual attendance
at present. Yrs Respectfully

Jan 21, '50 Wm Beaumont

Facsimile of letter written by Wm Beaumont in January of 1850
His irritation at insult to his profession is very evident.

St Louis Mo

Mar 4 1867

Yr Maddy of 16th Nov is just a 3 and 4 year
part covered with spunk - toothache

I shall send myself to you directly
and embrace the 10 last opportunity of forming
you sufficient authority to locate the Missouri
for a 3000 dollars each upon the last found
you can in the Military Reserve at St Louis
and anywhere or any other eligible land in the
State. But the better to secure a good land
time I will suggest that you go on, which
the last date you can expect. Watch your
steps, build a happy home or elsewhere
for 1000000 dollars. The year answer the
Maddie to cover the house or insurance
Conclude and thank Henry Althoff
or Mr. Althoff on the subject in

I forwarded my claim in due form
for my 1000000 dollars after the last was
forwarded to the proper Department. The letter
sent to the Com of Genl M. Charles who
presented them in person and made favorable
report and I am doing upholding the Missouri
-1000000 dollars - 1000000 - I have as yet
shall send them over to you with instructions

It would be time my business I shall
come over this spring. If I can not your
mother will most likely come with them
and I may come after

Yours, J. M. White has also been
rid and passed with much pleasure and
satisfaction. I shall write you again
soon in answer to your inquiries &c.

We are all pretty well now -
have been a little unwell with bad colds,
a week or two since -

Love to you all. Let me
hear from you often and believe me
Yr affectionate
Father

J. M. Beaumont

Gram 179

Missouri

irresponsibility and untrustworthiness of Alexis St. Martin, and the obstacles furnished by nature and the malicious designs of members of his own profession

These letters, represent a psychological cross section of the man, Beaumont, in several moods. One of them Dr. Beaumont wrote while irritated because he felt himself insulted professionally, the second, gives ample evidence that Dr. Beaumont was possibly not naive in business matters, and the last, in simple transcription, is a Christmas letter to his son, Israel Green Beaumont, which ends with an improvised poem portraying the affectionate father.

These letters are a part of an invaluable collection of Beaumontiana consisting of letters, personal effects, and various documents which will throw new and interesting light on Beaumont, his family, friends, business and military associates, and on the times in which he lived. During the spring of 1936, the University of Chicago was made the beneficiary, through the generosity of Mr. and Mrs. E. A. Beaumont, of DePere, Wisconsin, of this documentary material, which permits of a new and better evaluation of America's "Backwoods Physiologist."

Saint Louis, Missouri

Christmas Eve

Dec. 25, 1850

A merrie morrow to you—Bud—and may you enjoy it right merrily and morally with all our relations and friends there

And now you are on the spot and no doubt competent and feel confident in your own judgment, aided if necessary by timely counsels of your friends to manage my interests at the Bay for our mutual benefit and satisfaction

I shall submit the following subject and suggestions to your and Uncle Tommy's consideration and disposal — (Then follows directions relating to the handling of certain real estate located at Green Bay.....)

If you prove yourself pretty shrewd and discrete in this, I shall probably afford you other opportunities to exercise and improve your business faculties in the disposal of other parts of the property next season. I can add nothing to the information of my last a few days since. All in health and everything as usual.

Christmas has just come—and I must-go-to-bed 12½ O'clock a.m. and all the rest are asleeping—your Father-just-agoing—nod-ding—go-i-n-g-to-slee-p."

6 o'clock morning—all wide awake—

And kissing—for old Nick's sake—

Lapping lasses and Buckwheat cakes,

Sipping coffee—eating venison steaks—

Oyster soup and chicken fixings—

Hot rolls and butter made from strippings

Let us hear of your doings soon, and gratify your father

W B

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

AN excellent review of what is at present known of the physiology and clinical endocrinology of obstetrics and gynecology is presented by Kurzrok in his recent book.¹ Each section is followed by a valuable bibliography. The first third of the work is devoted to the physiology and chemistry of all the endocrine glands. The endocrinology of menstruation, ovulation, uterine motility, pregnancy and lactation is then discussed. Much of the author's own work has had to do with hormone assay in clinical ovarian syndromes. Hence, the chapters on amenorrhea, functional uterine bleeding, dysmenorrhea, the menopause, the toxemias of pregnancy, precocious maturity, intersexuality, and sterility are particularly interesting. Case reports include the results of hormone titrations. The book concludes with a chapter on methods of hormone assay.

One pleasant quality of the work is the frankness with which ignorance is admitted. As a result the author is able to indicate the next steps to be taken in research. Thus many problems are suggested. The approach to the clinical diagnosis and therapy is by definite deduction from established physiology. Hormone assay is used to demonstrate the functional relationships which exist in the patient. As a result this volume marks a definite advance over other endocrine treatises recently published.

PAUL STARR

¹THE ENDOCRINES IN OBSTETRICS AND GYNECOLOGY. By Raphael Kurzrok, Ph.D. M.D. Baltimore: The Williams & Wilkins Co. 1937.

A SMALL, well bound volume, well printed on good paper, is *Practical Talks on Kidney Disease*.² The book is broken into the usual topics when renal and vascular diseases are discussed. The author states that "this small volume is designed to assist the physician who practices general medicine to understand what is generally regarded as a difficult and confused subject. It is not intended as a monograph or text book." The author further states that he is "aware of the dangers in attempting to deal simply with such complex subjects and I plead guilty to many errors of omission which, however, can be easily corrected by further reading in certain books from which I have borrowed freely." The latter statement covers the main fault of the book. The material is incompletely and casually presented so that one seeking aid would be generally disappointed. General practitioners who are interested in therapy will not find an organized or aggressive program.

The author properly warns against the careless use of large doses of acid or alkali producing salts because of the ease of disturbing acid base equilibrium. He also ridicules the assaults which have been made all too frequently upon the hypertensive individual by needless dietary restriction, tooth extraction and like procedures.

M. HERBERT BARKER

²PRACTICAL TALKS ON KIDNEY DISEASE. By Edward Weis, M.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1937.

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MEDICAL RECORDS IN THE HOSPITAL. By Malcolm T. MacEachern, M.D., C.M., D.Sc., F.A.C.P., F.A.C.A., Chicago Physicians Record Co. 1937.

PRIMARY CARCINOMA OF THE LUNG. By Edwin J. Simons, M.D., Chicago: The Year Book Publishers, Inc. 1937.

ARTIFICIAL FEVER PRODUCED BY PHYSICAL MEANS: ITS DEVELOPMENT AND APPLICATION. By Clarence A. Neymann, A.B., M.D., F.R.S.M., Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1937.

MEDIZINISCHE PRAXIS. SAMMLUNG FUER AERZTLICHE FORTBILDUNG. Edited by L. R. Grotte, A. Fromme, and K. Warneke. Vol. 24—*DER VITAMINHAUSHALT IN DER SCHWANGERSCHAFT.* By Dr. med. Gerhard Gaethgens. Dresden and Leipzig: Theodor Steinkopff, 1937.

INSUFFLATION TUBAIRE KYMOGRAPHIQUE PAR LA METHODE DE RUBIN, ETUDE DE LA PERMEABILITE ET DU

FONCTIONNEMENT DES TROMPES PARTICULIEREMENT EN VUE DE LA STERILITE. By Louis Bonnet. Paris: G. Doin & Cie, 1938.

LA TACTIQUE OPERATOIRE. Published under the direction of M. Robineau and W. Stern. *TACTIQUE OPERATOIRE GASTRO-DUODENALE.* By M. Chaton and W. Stern. Vols. 1 and 2. Paris: G. Doin & Cie, 1938.

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A METHOD OF ANATOMY: DESCRIPTIVE AND DEDUCTIVE. By J. C. Boileau Grant, M.C., M.B., Ch.B., F.R.C.S. (Edin.). Baltimore: William Wood & Co., 1937.

THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George F. Gask, C.M.G., D.S.O., F.R.C.S. (Eng.) and J. Paterson Ross, M.S. (Lond.), F.R.C.S. (Eng.). 2d ed. Baltimore: William Wood & Co., 1937.

GENITAL ABNORMALITIES: HERMAPHRODITISM AND RELATED ADRENAL DISEASES. By Hugh Hampton Young, M.A., M.D., Sc.D., F.R.C.S.I., D.S.M. Baltimore: The Williams & Wilkins Co., 1937.



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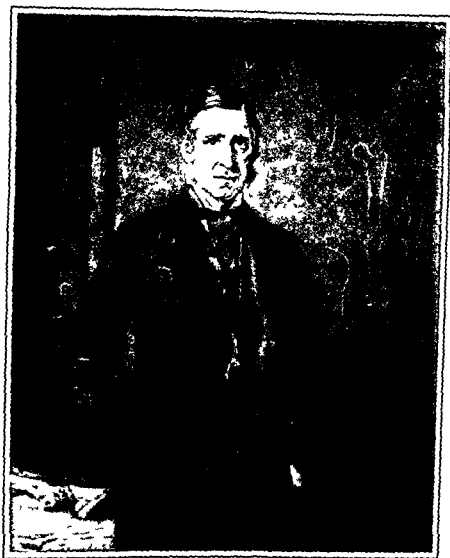
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Portrait of Sir James Paget, R.A.

Engraving by T. Oldham Barlow, R.A.

Sir James Paget

1814-1899

SURGERY

GYNECOLOGY AND OBSTETRICS

An International Magazine, Published Monthly

VOLUME 66

FEBRUARY 1, 1938

NUMBER 2

CLINICAL BEHAVIOR OF EARLY CARCINOMA OF THE CERVIX

WALTER SCHILLER, M D, New York, New York

EIGHT years ago, I made the first report on my study of the histological and clinical diagnosis of early carcinoma of the cervix, the pathological importance of the carcinomatous layer, and the possibility of establishing the diagnosis by means of the iodine test. Since this report the method has been tried by many gynecologists and pathologists both in Europe and America. In the United States numerous workers, among them Baxter, Emmert, Galloway, Graves, Henriksen, Martzloff, Norris, Schmitz, Sturgis, and Whytock have reported good results with the iodine test. Stearns, of the University of Nebraska, however, reported negative results in a series of 200 cases, but negative results in such a small series do not prove anything. Soon after publishing his report, Stearns informed me that he found a small leucoplacic area on the cervix of a 32 year old woman who complained of vaginal discharge. Biopsy revealed the smallest carcinoma ever diagnosed at the pathological Institute of the University of Nebraska. On a recent visit to Omaha I had an opportunity to see the microscopic section and found it to be a typical, beginning carcinoma with the characteristic oblique line of demarcation. Beattie, of England, Forgue, Pauchet, and Pouliot, of France; Coghlan,

of Australia, and Vogt, of Germany; as well as Boschetti, Casati, and Cuizza, of Italy, report good results and strongly recommend the iodine test as an aid in the diagnosis of early carcinoma of the cervix.

I am in a position to report 43 cases that have been observed for at least 5 years or more after operation. In all of them, iodine tests were made and revealed suspicious appearing patches on the cervixes. Subsequent microscopic examinations of tissue removed established the diagnosis of beginning surface carcinoma of the cervix. In only 1 of these 43 patients was there a recurrence. Therefore there were absolute cures¹ in 98 per cent of the cases. The patient with the recurrence died from paravertebral gland metastasis and there were also symptoms of compression of the large vessels. The case is of special interest because of the peculiar location of the metastases. The patient did not receive postoperative radiation treatment.² Examination of the extirpated uterus showed a superficial carcinomatous layer on the cervix. In one area there was typical, yet initial, invasive growth along and next to the glands of the cervical canal. The tumor was highly malignant. This

¹The cases have now increased to 51. Of these there was 1 recurrence and patient died and 1 recurrence and patient lived and is being treated with irradiation. In other words there were 49 cures in 51 cases.

²Reported by Kermanner in Halban-Seitz, vol 4 p 818, by the author in Arch f Gynaek., vol 133, p 277.

case did not exactly fit in with the classification of beginning carcinoma, the criteria of which were established later. Failure in this case does not rest entirely upon the diagnostic method used. It is true that in patients operated upon less than 5 years ago, there were 2 recurrences. The other cases in the series can not yet be declared "cured" as the 5 year period has not yet elapsed. The clinical failures in these 2 cases support the original histological diagnosis and prove that diagnosis of carcinoma from a superficial growth is justifiable.

Following is the report of a case

Antonie N., aged 59 years. Menstruation began at 16 years, was regular and of normal cycle. Patient had had 3 deliveries, no abortions. Menopause began 7 years ago. Patient complained of slight vaginal bleeding which lasted 1 week.

Examination revealed ptosis, cystocele the size of an apple, moderate rectocele, the uterus retroverted, hard, movable. An erosion was noted on the posterior lip and a healing erosion on the anterior lip. Painting of the cervix with iodine revealed two white patches, the larger patch on the posterior lip. Biopsy of the white area revealed an extensive superficial carcinomatous epithelium on an inflamed stroma. Operation consisted of vaginal extirpation of the uterus without the adnexa, anterior and posterior colporrhaphy with extensive resection of the vagina. Histological examination of the extirpated uterus revealed on the cervix extensive carcinomatous surface epithelium (Figs 1, 2, 3, 4 and 5). Patient was given three series of x-ray treatments and was examined again in February, 1936. At this time there were found brittle easily bleeding tumor masses at

the blind end of the vagina. Rectal examination elicited a definite sensation of an infiltrating mass reaching to the left pelvic wall. Biopsy showed the characteristic carcinomatous epithelium of comparatively great maturity, polymorphous nuclei and numerous mitotic figures. Patient was given 2 ray treatment and additional radium.

This case shows definitely that even when the growth extends only slightly into the tissues and a relatively radical operation is done, recurrence is possible. In this case the growth did not extend beyond the depth generally found in the third state of healing erosions. The small surface extension of this carcinoma was much greater than its invasion, but in spite of this fact recurrence took place. In their report of 16 primary cancers, Smith and Pemberton describe cases similar to this one, but they do not give exact data as to the size of the beginning carcinomas. Their photomicrographs prove beyond doubt the carcinomatous character of the lesions in their cases. However, they do not show whether the lesions had invaded the tissue or whether the area involved was great. Recurrence in some of these cases proved that the pathologists were wrong in their diagnoses of atypical epithelium without malignancy.

All patients in my series of beginning carcinoma were subjected to operation, that is extirpation of the uterus, as a rule the Wertheim operation. The limited extent of the

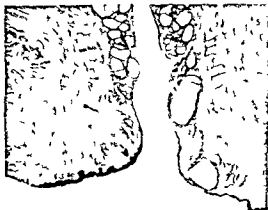


Fig 1. Low power. Carcinomatous layer (black) with 4 small plugs penetrating the deeper tissue. $\times 5$



Fig 2. Low power. The cervical canal immediately above the external os. The carcinomatous layer of the posterior lip spreads into the depth alongside of a cervical glands. $\times 50$

carcinoma and the high percentage of young women affected—and this percentage seems to be increasing, according to our latest experiences—make less radical treatment very desirable. Sufficient time has not as yet elapsed to report the results in the treatment of beginning carcinoma. Of the cases of Smith and Pemberton 6 patients were treated by trachelorrhaphy only and there were 4 recurrences. The 2 others have been observed one for 3 years, the other for 15 months only. Nine of the patients were treated by means of excision, cauterization, or trachelorrhaphy, plus subsequent application of radium. Of these 9 patients, 8 remained cured, 4 patients having been observed over a period of less than 5 years. The impression seems to be gained from this series of cases that radium treatment greatly improves the prognosis.

Schmitz published the report of a case of amputation of the cervix in which an early carcinoma had been overlooked. Recurrence took place and healing was effected with radium. Simple amputation of the cervix is evidently not sufficient in most of the cases, especially not a low or flat amputation. Even after a high Sturmdorf amputation, recurrence will take place in some cases, because the carcinomatous surface epithelium reaches high up into the cervical canal, and the amputation has not been done well within the normal tissue. Radium application in the cervical canal destroys carcinomatous layers, with certainty, even those extending up to the internal



Fig 3 Normal epithelium, left, carcinomatous layer, right. The beginning inflammatory infiltration of the stroma coincides with the carcinoma. $\times 60$

os. The fact that recurrences sometimes follow removal of superficial carcinomatous layers which do not invade the deep tissues justifies the theoretical basis on which the early diagnosis of carcinoma is made, namely, that carcinoma of the cervix begins as a superficial layer without any downgrowth invasion. The application of iodine to the cervix makes the lesions visible to the naked eye, thus facilitating the early diagnosis. The reaction is not a specific one, but the use of iodine is a rapid and practical way of finding suspicious alterations that might otherwise escape the examiner. Microscopic examination of tissue from the white patches is necessary to establish a definite diagnosis.

That carcinoma may be present as a superficial layer only without invasion of the deeper

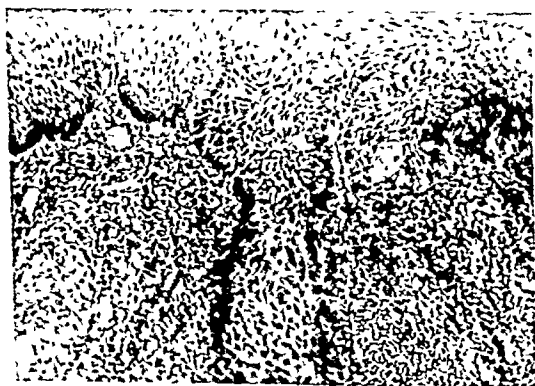


Fig 4 Carcinomatous layer of the posterior lip, a poorly demarcated plug creeps into the depth. $\times 95$



Fig 5 Carcinomatous layer of the posterior cervical lip. $\times 95$

tissues is now an almost generally accepted fact. Authors who do not make a definite diagnosis of carcinoma unless there is evidence of an invasive growth (Franque and occasionally Hinselmann) designate these superficial carcinomas as "carcinoid" or "precancerous" tissue but clinical treatment is given the same as for malignant growths. From a practical point of view, these differ only in that they use a different terminology and do not feel justified in diagnosing carcinoma on the cytological character of the epithelium only. To bring the two conceptions together would be desirable for the following reasons. Biopsy makes possible examination of only a small piece of tissue. It occasionally happens therefore that one specimen of tissue removed contains none of the malignant lesion while a second specimen or the gross specimen itself if operation is done will reveal an invasive growth close to the area affected by the surface lesion which was noted in the first specimen.

In such cases the authors who use the terms "carcinoid" and "precancerous" for surface growth without deeper invasion would discuss the condition as follows. The first biopsy shows precancerous or carcinoid surface epithelium, therefore, it is possible, even probable, that the tissue in the nearby area contains fully developed carcinoma with deeper invasion. This possibility or probability not only justifies but necessitates the use of measures as radical as would be used if the first biopsy had shown carcinoma already invading the deeper tissues. Thus they use the same treatment for "surface layer" carcinomatous lesions as for carcinoma already affecting the deeper layers. Therefore I believe it would be a step forward if the pathologists would classify both types of lesions as carcinoma.

In the rare case a small patch of carcinomatous epithelium is present but the superficial carcinomatous layer is very extensive and one or both lips of the cervix may be involved before there is any significant ulceration. In such cases, the surface epithelium is not so transparent or shiny as normal but it is not eroded or ulcerated. Unless colposcopic examination is done or the iodine test is used, these lesions may be easily overlooked. Microscopic examination of the surgical speci-

men in such a case may show a surprising amount of invasive growth which sometimes reaches as far as the isthmus or the corpus. The invasion is not general, it may be present in one or two places, usually near the external os. Sometimes it is necessary to make serial sections to locate the area in which the carcinoma broke into the deeper layers. Of the three characteristic properties of carcinoma—superficial growth, invasion, and ulceration—this type possesses chiefly the first two. To a certain extent these lesions resemble the endophytic carcinoma without superficial ulcerations as are sometimes found in the presence of prolapse.

Hoegler reported a case of prolapse in which a carcinomatous layer of the cervix developed from slightly eroded hyperkeratotic epithelium, which in turn gave rise to a carcinoma extending up to the fundus. I reported a case without prolapse in which the carcinomatous layer affected the cervix but did not invade the deeper tissue and there were no ulcerations.

A brief report of another case characteristic of this type follows.

M. F., aged 43 years. Menstruation began at 13 years, occurred every 4 weeks, lasted 3 days, and was regular. Patient had had 3 spontaneous deliveries, no abortions. For the past 4 months the menstrual period had been prolonged to 1 week and bleeding had increased.

Examination revealed an edematous mons, left thigh edematous, skin tense. The vulva gaped and there was a moderate cystocele. The uterus was enlarged, hard and movable, the left parametrium was hard with cord-like infiltrations, the cervix was smooth and plump. Pieces of endometrium and a small piece of typical carcinomatous surface epithelium with cervical glands opening through were obtained from curettement.

At laparotomy a fairly enlarged uterus was found and there were several flat white areas of metastases on the parietal peritoneum, two fingers to the left of the uterus. A node the size of a walnut was noted in this area. Examination of the extirpated uterus showed the presence of a circular carcinomatous layer affecting the whole cervix and around the external os, a small area of glandular inflammatory eroded tissue, part of which was covered with carcinomatous epithelium which plugged some of the cervical glands—resembling normal epithelium in the third stage of healing. Next to this the stroma of the portio was free of carcinoma. Higher up in the wall of the cervical canal there were numerous small patches and trabeculae of carcinomatous tissue. Mc-



Fig 6 Low power Carcinomatous layer (black) on the surface of the portio, carcinomatous plugs are noted in the lymph vessels and perivascular lymph spaces of the portio stroma $\times 5$

tastases filled the lymph spaces, especially those around the large arteries. Near the cul-de-sac of Douglas the areas of metastases increased in size, to form large, partly solid, partly reticulated masses (Figs 6 and 7). It seems that the carcinoma here perforated through the peritoneum and had formed the deposits which were noted during the operation.

This case is an example of a generalized, spreading carcinoma which had no superficial ulcerations, but which had developed from a small area of invasion. A biopsy specimen from any part of the cervix except a small area at the external os would have revealed nothing but a so called superficial layer without invasion and yet it was found to be an advanced inoperable lesion.

The basis for our theory is that carcinoma of the cervix is of superficial and not of deep origin. The earliest phase of the carcinoma is the *superficial carcinomatous layer*. To Kermanner and Schottlaender (1912) goes the credit for recognizing it as a *special form* of growth in some advanced cases of uterine carcinoma. Their predecessors, Pronai and

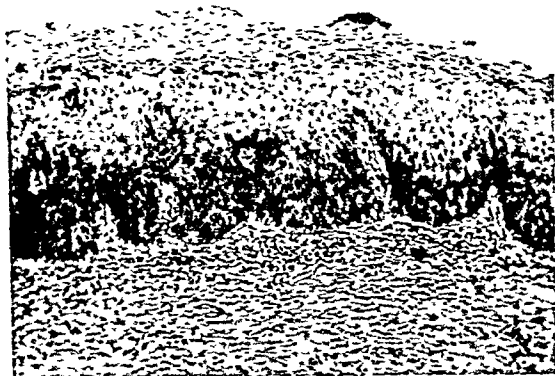


Fig 7. Carcinomatous layer of the portio covered with a thick layer of parakeratosis $\times 95$.

Schauenstein, described only a few cases. Kermanner and Schottlaender, however, did not identify specifically the surface layer next to the area containing the advanced stage carcinoma in primary uterine cancer, the presence of which I was able to prove. Today many workers discard the old criteria in arriving at a diagnosis of uterine carcinoma and base their decision on the type of cell alone, even though the cancer cells are noted only in the superficial layers (Keller and Van de Vyver, Graves, Freedman, etc.). Broders (1932) found in the epithelium of the larynx, mandible, skin, rectum, and other organs, deep invasive epithelial changes of benign character as well as superficial changes of malignant character.

The iodine test makes it possible to diagnose the presence of carcinomatous layers clinically, thus making early treatment possible. The value of this test is evident in the reports of cases in which the patients were treated for early carcinoma. The diagnosis of very early carcinoma of the cervix can be made only in patients who are examined for some other illness or who make it a practice to have periodical gynecological examinations.

In a review of early carcinoma cases¹ I made a special study of the objective signs and subjective symptoms; unfortunately a single specific sign or symptom was not to be found. The characteristic syndromes of advanced

¹Wien. med. Wchnschr., 1931, No. 36.



Fig 8 Carcinomatous layer with 2 thick plugs the one on the left shows that central disintegration has taken place $\times 150$



Fig 9 Low power Cervical canal just above the external os a carcinomatous layer is present on the anterior lip $\times 5$

carcinoma—anemia, loss of weight, etc—are absent. These signs are probably sequels of advanced carcinoma, not precursors of primary carcinoma. Some of our younger patients with primary carcinomas were in excellent physical condition. The only specific symptom found in some of the cases was contact bleeding. This was noticed even in patients in whom the carcinomatous layers were only a few square millimeters in size. The cause of this bleeding is the brittleness of the carcinomatous epithelium, the atypical basal cells of which are not in firm contact with the underlying inflamed stroma. It can be stated with certainty that early carcinoma of the cervix as a general rule does not produce subjective symptoms or illness which would cause a patient to see a gynecologist.

At the present time a study is being made of the latent period in cervical carcinoma—that is, the interval between the true onset of the carcinoma and the appearance of noticeable signs and symptoms. According to Fesch, Goecke, Stahler, and others, the latent period may last several months. However, their methods of diagnosing carcinoma in an early stage differs completely from that of Hinselmann, Graves, Pemberton, Smith, Beattie, and myself. Carcinoma designated 'early' by Fesch and others is far too advanced to be compared with the early carcinoma detected by means of the iodine test. The classification

of Goecke does not include the lesion found in the true initial stage. The classification of uterine carcinomas as proposed by the Hygiene Committee of the League of Nations, completely ignores the early stages. According to this classification, there are four phases of uterine carcinoma: (1) carcinoma limited to the uterus, (2) carcinoma with slight infiltration of the parametrium, (3) carcinoma with infiltration which is marked but which does not reach to the pelvic wall, (4) carcinoma with parametrial infiltration which affects the pelvic wall and in which eventually metastases appear.

The duration of the "early stage" is important from the therapeutic point of view. If the 'early stage' (superficial carcinomatous layer) were of several days' or weeks' duration only, then the chances of early diagnosis would be very small, it would be difficult to make early diagnosis the rule for that would require systematic, periodical examinations, an impractical requisite if the intervals between examinations were too short (1 or 2 months). It is believed, however, that the primary phase is of long standing. The histological resemblance between early carcinoma of the cervix and Bowen's dermatosis might be mentioned. Bowen's dermatosis differs completely from all other carcinomas of the skin because there is such a long interval between the superficial and the invasive growth. At first Bowen's



Fig 10. A carcinomatous layer with large, plump plugs growing toward the cervical glands $\times 21$

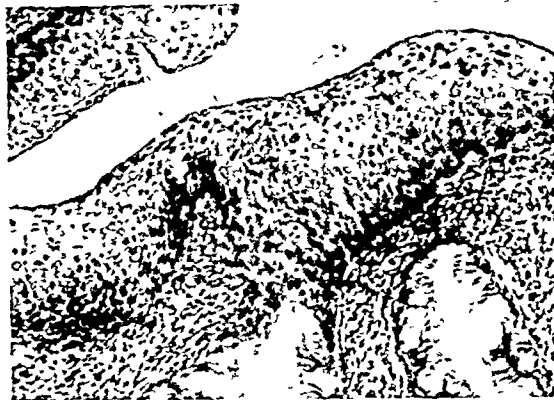


Fig 11. Carcinomatous layer with a deep fold on the left; in the center there is a plug growing toward a cervical gland. Note the polymorphous and atypical cells and the frequent mitosis $\times 110$

dermatosis was not considered as carcinoma of the skin because it was not known that the superficial lesion became invasive only after a latent period of several years. In the usual type of carcinoma of the skin the surface phase is so short that the lesion is seldom diagnosed before it has penetrated the deep tissues.

Since Bowen's dermatosis morphologically resembles early carcinoma of the portio, it is likely that the two also have some biological properties in common, for instance the long phase of surface growth. This cannot be proved by clinical observation, however, because as soon as it is determined that a carcinomatous layer of the cervix is present it is our duty to treat the lesion radically, whether we regard it as carcinomatous or precarcinomatous, the carcinomatous layer must be removed or destroyed well into the healthy tissue, through amputation of the cervix, total extirpation, or radium treatment. Therefore, it is impossible to say how long it would have taken for the surface layer to send trabeculae or plugs into the depth. Lesions properly diagnosed and properly treated throw no light on the subject. It is only in the cases classed as failures, clinically, that we can obtain some information; for instance, in the first biopsy a malignancy may not be recognized but it may be noted in a later examination. In such a case, we can compare the sections from the two examinations and note the process of growth. Again some patients refuse treatment after a definite diagnosis has been made. Later these patients may again seek advice and we then have the opportunity to investi-

gate and note any changes which may have taken place in the lesion during the interval.

To make these two sources of information of any value, one condition must be fulfilled, that is, the carcinomatous tissue must not be entirely removed at the first biopsy. In my experience complete removal of the pathological tissue is seldom accomplished. If tissue is removed from a carcinomatous layer several millimeters thick, it is true that in a relatively short time the tissue will replace itself. Let us consider the non-radical operations for malignancy. If the smallest piece of tumor tissue remains it will cause a recurrence if sufficient time elapses for it to develop. The same is true also of surface carcinoma. Experiments have shown that when a small piece of epithelium is removed from the cervix regeneration takes place in a short time. We know that epithelium with so marked a tendency to grow as is ascribed to carcinoma, is able to replace itself in a short time.

If we assume, in a special case, that the entire suspicious appearing tissue has been removed through biopsy and if later examination reveals the presence of carcinomatous tissue, there is only one explanation, namely, that a primary carcinoma has appeared a second time at the site of the first carcinoma. This assumption has been made several times by Smith and Pemberton (Case 15), by Hinselmann, and by Kamniker, but they did not



Fig 12 Low power biopsy specimen To the right from the midline a gland orifice is breaking through a carcinomatous layer (black) $\times 75$



Fig 13 A carcinomatous layer of tissue which was found penetrating into the depth alongside of a gland $\times 110$

prove that the original carcinoma was radically removed, without such proof the idea of the repeated production of carcinoma at the same site deserves no credit

Local recurrence after removal of an advanced carcinoma is never regarded as a secondary independent growth, but as the result of incomplete removal of the primary carcinoma¹

The 3 following cases are presented as examples of so called clinical failures in 2 of them carcinoma was not diagnosed at biopsy, in the third case carcinoma was diagnosed but the patient refused treatment In the first 2 cases there were failures in diagnosis but in each there is an explanation, even an apology In the second case a microscopic ex-

amination was made in 1923—before our method of diagnosis had been established In the first case examination was done by a substitute whose experience was not sufficient to enable him to settle so difficult a problem in diagnosis In both cases the diagnosis was "suspicious" of malignancy only and adequate treatment was therefore not carried out

Anna J aged 34 years Menstruation began at age of 13 years was regular until 6 years ago when it became irregular, every 3 or 4 weeks and the flow was scanty Patient was a tripara Last parturition occurred 7 years ago and there had been an abortion without any complications 6 years ago Patient came to the clinic because of a 6 months period of amenorrhea Biopsy specimen was taken from a suspicious appearing area on the portio The gynec-

¹The same explanation must be used for the primary carcinoma.



Fig 14 Low power On the posterior lip a carcinoma (black) is disintegrating through inflammation The anterior lip is normal $\times 4$



Fig 15 Carcinomatous layer of tissue with a plug that is seen to be extending toward a cervical gland $\times 110$

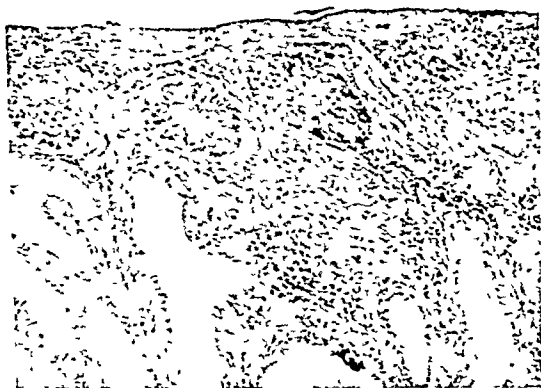


Fig 16 Three small carcinomatous plugs between cervical glands $\times 66$

cologist found a suspicious area on the cervix. The substituting pathologist made a diagnosis from the biopsy specimen of atypical epithelium, possibly suspicious of carcinoma. But the slide showed characteristic carcinomatous surface epithelium with the typical demarcation line between the normal and the carcinomatous epithelium (Fig 8). After curettage and radiation treatment of the pituitary body the patient was discharged and 6 months later she was menstruating again. Sixteen months after the first examination the patient returned. The suspicious area had not changed in size or appearance. Careful re-examination of the original biopsy specimen as well as of new material showed definite carcinoma cells. A Wertheim operation was performed. Sections of the extirpated uterus showed a typical, superficial carcinomatous layer at the external os. This growth projected somewhat into the cervical

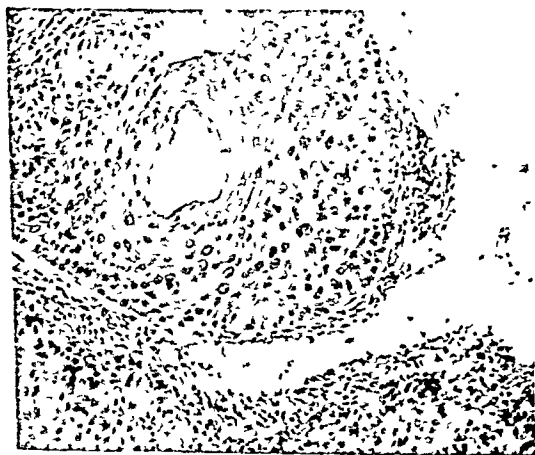


Fig 18 Carcinomatous layer, horizontal section, note the polymorphous cells and the irregular distribution of the nuclei $\times 110$

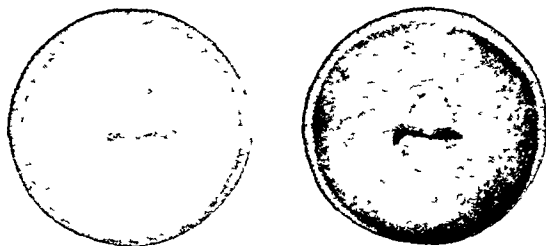


Fig 17 a, left. Portio with indistinct, blurred patches around the external os b, The same area after iodine application. A triangular, sharply demarcated, white area of leucoplacia (carcinomatous layer) is noted. On the posterior lip arranged in a circle, are several bright, yellowish-brown, poorly demarcated leucoplacic areas (histologically leucoparakeratosis). To the right of the os are 4 bright spots, which correspond to cystic glands. Repeated examinations showed that the leucoplacic areas which corresponded with the carcinomatous layer remained unchanged; the areas of leucoparakeratosis changed in appearance and size.

canal and reached into the depth along with some glands. Scattered among the normal epithelium there were short plugs which shut the gland openings and resembled erosions in the third stage of healing. The cytological structure, the very polymorphous and hyperchromic nuclei, the numerous giant cells, and the areas of crowded atypical mitosis made the diagnosis of carcinomatous layer certain. The most invasive plug was slightly over 1 millimeter in length. In the 16 months between the first biopsy and operation there was hardly any significant spread of the carcinoma, either on the surface or deep in the tissues (Figs 9, 10, 11). The lesion did not extend beyond the downgrowth of the normal epithelium in the neighboring erosion.

Elizabeth S., aged 38 years. Menstruation began when patient was 16 years of age, occurred every 4 weeks and lasted 6 to 7 days. She had had 3 normal deliveries with no abortions. For the past year the periods had been irregular, for past 6 months there



Fig 19 Inconstant area of leucoparakeratosis (right) of anterior lip changing into hyperkeratosis with keratohyaline layer (left)

had been slight contact bleeding and yellow discharge. Patient missed one period and wanted to know if she was pregnant.

Examination January 31, 1923, revealed a small cystocele, retroverted and somewhat movable uterus and the left adnexa thickened and tender. On both cervical lips there were small erosions. Tissue the size of a pea was taken from the erosion of the anterior lip which appeared suspicious of malignancy, because of its rough appearance. Biopsy revealed a glandular inflammatory, partly healing erosion. The squamous surface epithelium was partly shed at the edge of the slide; only there was a small piece of stratified epithelium—diagnosed "not suspicious." The patient was treated with topical applications of pyrolysic acid and was discharged. Examination 7 months later revealed a 3 months old pregnancy. She was delivered at term without any complications. Six years later she again went through a normal pregnancy. Both times she was delivered normally at home. One year after her last delivery she returned to the hospital because of a slight contact bleeding. Upon examination a small cervical polyp and a slightly bleeding eroded area on the anterior lip was found. The erosion could not be broken through by a probe (negative Chrobak test). Scrapings from the lesion definitely established the diagnosis of a superficial carcinomatous layer. The piece of tissue excised at the first examination was mounted on paraffin, and cut into serial sections. Careful study showed a small area of carcinomatous tissue in the eroded glandular area which reached to the edge of the block, thus showing that it had not been radically removed (Figs. 12, 13). In view of the old and the new findings the uterus was extirpated. Sections through the cervix showed a narrow strip of carcinomatous tissue in the region of the anterior lip. The carcinomatous tissue was resting on an inflammatory stroma partly extending over a glandular inflammatory eroded area. There were several small cones extending into the depth along the cervical glands, the longest of these did not exceed 1.2 millimeters. The findings in this case are more remarkable than in the first case. At the time of the first examination there was a small superficial carcinoma proved by the serial section. This was partly removed though not completely through removal of the biopsy specimen. Nine years later the patient was operated upon. During this interval she went through 2 normal pregnancies and in spite of this the carcinomatous layer did not make very significant progress (Figs. 14, 15, 16). The invasion into the tissue was no deeper than the normal epithelium in the area of the healing erosion.

The third case belongs to the second group. Carcinoma was diagnosed but the patient refused operation.

Maria C. aged 45 years. Menstruation began when patient was 13 years old, was regular, occurred every 4 weeks, and lasted 3 to 4 days. Last men-

strual period occurred 3 months ago and patient wants to know whether she is pregnant or not. Upon examination the following was found: a somewhat enlarged hard uterus anteflexed, slightly movable adnexa and parametria negative. On the right side of the anterior lip there was a small, oval shaped sharply defined area, the epithelium in this area appeared somewhat elevated and dull. Iodine application revealed a white sharply defined area of leukoplakia on a dark brown cervix. Scraping from the edge of the lesion showed a typical carcinomatous growth with polymorphous cells, hyperchromatic nuclei and atypical mitosis (Figs. 17, 18, 19). The patient refused operation or any other treatment in spite of repeated warnings. Eighteen months later we prevailed upon her to return for an examination. Surprisingly enough, we found that the carcinomatous lesion had not changed either in appearance or in size. Comparison between a sketch made at the first examination and the present condition definitely proved that the small surface carcinoma had remained stationary during the 18 months period. The part removed at the first curettage had been restored yet with no increase in size. The second biopsy showed carcinomatous surface epithelium of exactly the same type as that taken 18 months before.

SUMMARY

These 3 cases illustrate clearly that there is not only a biological but a morphological analogy between early carcinoma of the cervix and Bowen's dermatosis. The period of surface growth is exceptionally long in both types of carcinoma. Months sometimes several years, pass before the surface carcinoma begins to penetrate the deeper tissues. The spread into the lumina of the glands should not be regarded as invasive because the normal epithelium has the same tendency in healing erosions. The two dimensional superficial growth of the carcinomatous layer also is very slow. Our cases show that many months may pass before there is any appreciable change in the size of the lesion. Rapid and excessive growth, which has always been ascribed to malignant tumors, apparently does not occur until the carcinoma has reached a definite size, a certain amount of superficial disintegration, and some invasive growth. This may be called the secondary stage (Paltauf) and is characterized by the spread along the lymph spaces and by way of the lymph vessels to the lymph nodes. In the primary stage the malignancy is confined to its primary site and is characterized by slow growth.

The primary stage of solid cervical carcinoma lasts several months, sometimes a few years. This fact that the primary stage of carcinoma of the cervix, which represents 90 per cent of all carcinomas of the uterus, lasts for some time makes early diagnosis possible. To make early diagnoses possible periodic examinations, at least twice a year, would be necessary. Periodic examination would guarantee a patient that in case she developed carcinoma of the cervix, the growth would be recognized as carcinoma at a phase early enough in development to assure permanent cure in probably 95 per cent of the cases.

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NOTES ON CUTANEOUS HEALING IN WOUNDS

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THE attention of the surgical world is so centered upon the serious problems of morbidity, mortality, and functional results of surgery that it may seem elementary to present the subject of the healing of the skin in clean incised wounds. However, in the course of examination of nearly 1000 healed wounds in the surgical follow up clinic of the New York Hospital, the variation in the degree of fibroblastic response in healing by first intention was so great that the subject was deemed worthy of study.

Excellent observations on the physiological rules governing the rate of cicatrization in wounds may be found in the experimental works of Carrel, Carrel and Hartman and DuNouy (4). These investigators have shown that a healing wound undergoes a latent or quiescent period which ends abruptly and is followed by a period of contraction. DuNouy (5) developed a mathematical equation by which the rate of healing in a given wound can be expressed, its normal course predicted, and the time of its completion forecast. Howes, Sooy and Harvey demonstrated by experimental work on animals that the tensile strength of a healing wound depends upon the firmness of fibroblastic response. The maximal strength of the wound, according to their studies is attained in from 10 to 14 days. It is well known that the rate of cicatrization as well as the extent of fibroblastic response varies in different individuals. Furthermore these variations may be influenced by alteration of certain external factors which are under the control of the surgeon during incision, suture and subsequent care of the wound. The experiments performed by Clark suggested to him that epidermization is unaffected by diet. Ebeling's work with experimental animals led him to the conclusion that increase in environmental temperature may accelerate the rate of cicatrization.

It is the purpose of this paper to point out that certain details in the technique of surgical incision and suture have a direct effect upon the degree of fibroblastic response in a clean incised wound and also upon the ultimate cosmetic result. This observation is based on the appearance of scars, photographed 1 to 3 years after

operation and consideration of the ultimate result in relation to the variations in the surgical technique employed.

TECHNIQUE OF INCISION

Incisions should be made parallel to Langer's lines of elasticity of the skin if minimal cutaneous cicatrization is desired and widening of the scar is to be avoided. In operations about the face and neck, the direction of these lines of elasticity is usually observed since they can be defined easily through facial grimace. However, in operations on the abdomen and extremities primary importance is attached to exposure of the wound and attention rarely is paid to the direction of the incision as regards cutaneous tension.

Lower quadrant abdominal oblique incisions. In Figure 1 is shown a photograph of an oblique right lower quadrant abdominal incision made for hernioplasty. The gradual widening of the scar toward the lower end of the incision is a common observation in wounds obliquely placed in this anatomical region. This photograph was taken 1 year after operation had been performed and the wound had healed *per primam*. It has been noted repeatedly that when obliquely placed lower quadrant abdominal incisions are made, they show a wider separation of the cutaneous margins at the lower end of the wound than in the upper portion. The variation in the degree of tension on the wound margins at the upper and lower ends is reflected in the greater width of the resultant scar in its lower portion. These observations have led me to the belief that the lines of elasticity of the skin run transversely in the suprapubic area rather than obliquely vertical as Langer's diagrammatic figure represents them. It is recalled that Langer's observations regarding cutaneous tension were made on cadavers. It is possible that the physiological elasticity of the various surface regions may be different in the living subject. Observation of 100 patients in whom oblique right lower quadrant incisions for appendectomy or hernioplasty had healed by first intention showed this same type of widening of the cutaneous scar at the lower end of the wound in 62. In 37 patients the cutaneous healing was ideal, fibroblastic response was minimal. In 1 patient, a tendency to keloid formation was manifested.

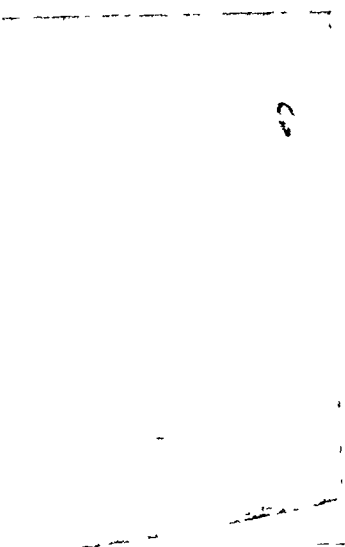


Fig 1

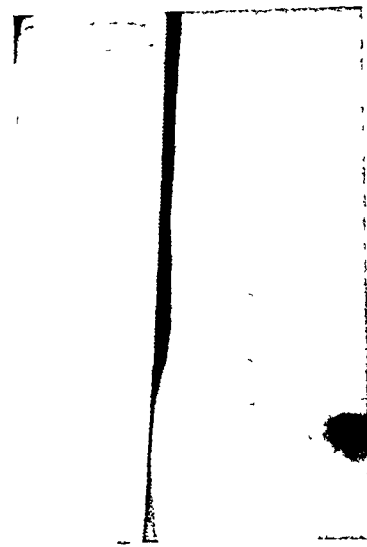


Fig 2



Fig 3

Fig 1. C A Photograph of scar taken 1 year after inguinal hernioplasty. Note the fine linear cutaneous scar in the upper portion of the wound and the widening of the scar to the width of 1 centimeter in the lower portion of the wound.

Fig 2. B S Variation in degree of fibroblastic response at different levels in the same incision. In the upper portion of the wound the cicatricial response is minimal and healing is ideal. In the lower portion the scar is hypertrophic. Operation was performed for gall-bladder disease. Photograph was taken 3 years after operation. The patient did not gain weight after operation. The wound healed *per primam*. It is believed that this variation in fibroblastic response can be explained only on the basis of variation in the technique of incision and suture at the

two levels in the wound. Probably this incision was beveled in the lower part and the cutaneous edges in that area were poorly approximated in the suture.

Fig 3. M R Photograph of scar of right rectus incision made for cholecystectomy. Photograph taken 2 years after operation. This patient did not gain weight in 2 year period after operation. Note the segments of fine linear cicatrix alternated with areas of hypertrophic scar. The upper segment with excessive reaction represents the point of emergence of the abdominal drain. The lower segment of hypertrophic scar can be accounted for only by beveling of the incision or by poor approximation of the cutaneous margins in the technique of suture. There was no infection and no separation of the edges of the skin after removal of sutures.

TABLE I.—OBLIQUE INCISIONS IN RIGHT LOWER QUADRANT OF ABDOMEN

	No cases
Uniform widening of scar	0
Ideal healing—minimal scar	37
Widening of scar at lower end	62
Keloid formation	1
Total	100

Technique of incision of the skin. It is well known that it is important to hold the skin taut while it is being incised so that incision may be made sharply at a right angle to the flat cutaneous surface. If this technique is not followed the operator may divide the layers of the skin in an oblique plane—the so called “beveled” incision. It is difficult accurately to suture the edges of such an incision in close approximation.

Vertical incisions in the right upper quadrant of the abdomen. Diffuse widening of the abdominal scar to a width of 0.8 centimeter or more was

noted in 118 of 225 patients in whom vertical incisions had been made in the right upper quadrant of the abdomen in operations on the biliary tract. Additional factors which, it is believed, influence unfavorably the healing of wounds in this area are the increased mobility of the upper abdominal area due to respiratory movement and the tendency of many patients to gain weight after operation. It is felt that the constant motion of the upper abdominal wall may increase cutaneous tension and thus exert force on the line of healing at a time when the maximal tensile strength of the wound has not yet been reached. Postoperative gain in the weight of the individual is accompanied by an increase in the volume and depth of the panniculus adiposus so that cutaneous tension is also increased by this factor. An increase in weight of 10 to 30 pounds in the postoperative period has been considered sufficient to cause an increase in cutaneous tension in the region of the right upper quadrant wound.

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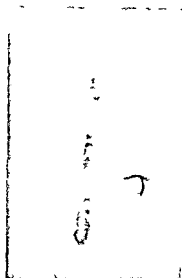


Fig 4

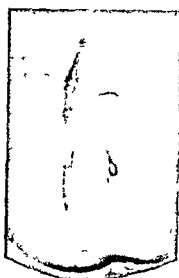


Fig 5

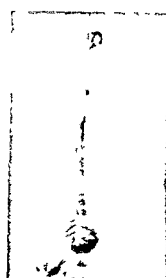


Fig 6

Fig 4 CT Scar of an upper right rectus incision made in operation for gall bladder disease. Here again the areas of hypertrophic scar are irregularly alternated with finely healed scar. Photograph taken 3 years after operation. The patient did not gain weight after operation. There was no infection and no separation of the edges of the skin after removal of the stitches.

Fig 5 OP Shows hypertrophied scar in the long leg of a hockey stick incision made for cholecystectomy. The small upper angulated portion of the incision has not formed hypertrophic scar probably because its direction more nearly parallels that of Langer's lines.

Fig 6 CS Scar of midline lower abdominal incision taken 4 years after operation. Note the fine linear cicatrix in the upper portion of the wound. The hypertrophic scar in the middle can be accounted for only by beveling of the incision or poor approximation of the cutaneous margins in the technique of the suture. The nodule of hypertrophic scar at the lower end of the incision represents a point at which minor infection with draining sinus was present. A catgut suture was expelled from this point. This type of localized nodular hypertrophic scar is often seen in wounds which have been sutured with catgut.



Fig 7 SR Photograph of a scar on the dorsal thoracic region resultant from the excision of an elliptical segment of skin and subcutaneous fat. The cicatrix has widened to 3 centimeters. Adequate mobilization of the lateral flaps by undercutting might have given more ideal cutaneous healing.

Of 118 patients whose scars showed diffuse widening, 89 had gained 10 to 0 pounds in weight while in 60 of the 84 patients who showed ideal linear scar formation there was no significant gain of weight.

TABLE II—VERTICAL INCISIONS IN RIGHT UPPER QUADRANT OF ABDOMEN

	No. cases
Uniform widening of scar to 0.8 cm. or more	118
Ideal healing—minimal scar	84
Healing with irregular scar	23
Keloid formation	0
Total	225

In 23 patients irregular healing of the upper abdominal scar was noticed. It is believed that this segmental alternation of finely healed cicatrix with areas of hypertrophic scar is due to the following factors: infection at the point of emergence of abdominal drains; beveling of the incision; and irregular approximation of cutaneous margins in the suture of the edges of the skin.

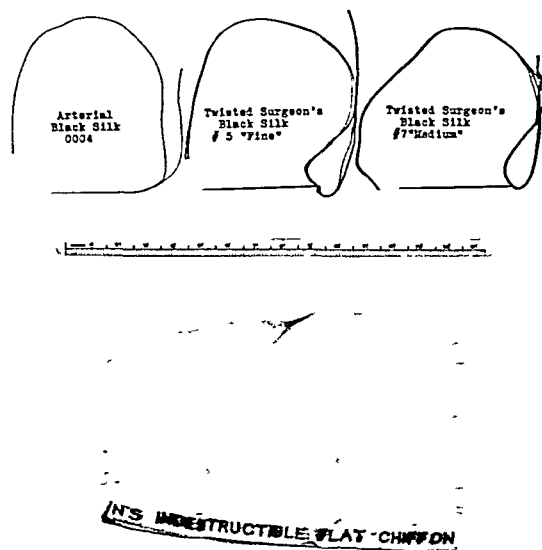


Fig 8 Fine arterial silk used for approximation of the edges of the skin in wounds about the face is shown in comparison with the ordinary No 5 fine black silk. The material used for the crêpe lisse dressing is purchased at any department store as indestructible flat chiffon.

Lower abdominal vertical incisions In 25 mid-line incisions in the lower abdominal region, made for operations on the female pelvic organs, cutaneous healing was ideal in only 12. In none of the patients was diffuse widening of the scar noted as in the study of upper abdominal wounds. In the other 13 patients the scar showed segments of hypertrophic scar. All but 2 of these wounds were sutured throughout with catgut. The fact that a suture of catgut excites more cellular reaction than does a silk suture was pointed out by Halsted (7). Howes has recently demonstrated in experimental wounds that those sutured with silk showed fibroblastic proliferation earlier and the wounds accumulated strength more rapidly than did those sutured with catgut. The frequency with which these wounds, sutured with catgut, drain seropurulent material from small openings in them probably accounts for the irregular scar formation in these cases.

TABLE III—INCISIONS IN MIDLINE OF LOWER HALF OF ABDOMEN

	No cases
Uniform widening of scar to 0.8 cm. or more	0
Ideal healing—minimal scar	12
Healing with irregular scar	13
Keloid formation	0
Total	25



Fig 9 A R. Photograph of scar taken 1 year after pericardiectomy. Note the hypertrophic scar in the upper transverse arm and the vertical portion of the incision. The lower transverse portion has healed without hypertrophic scar formation.

Cervical incisions Of 50 patients in whom the usual "collar" incision was made for thyroidectomy, healing was ideal in 41 patients. In the

TABLE IV.—CERVICAL INCISIONS ("COLLAR" INCISIONS FOR THYROIDECTOMY)

	No cases
Uniform widening of scar to 0.8 cm. or more	0
Ideal healing—minimal scar	41
Healing with irregular scar	0
Hypertrophic scar—slight	9
Keloid formation	0
Total	50

9 others there was slight hypertrophic reaction throughout the scar. In none of the patients was irregular cutaneous healing noted. The high percentage of cases in which healing was ideal is thought to be due to the fact that, in the technique of the suture of the "collar" incision, the

platysma muscle is neatly sutured in a plane separate from the line of suture of the skin and that cutaneous tension is relieved by the wide undercutting of flaps necessitated in the operation for thyroidectomy.

TECHNIQUE OF SUTURE

In an attempt to obtain more accurate approximation of the incised margins of the skin, fine arterial silk threaded on small straight needles of the milliner's type has been used (Fig. 8). This very fine suture material allows for accurate coaptation of the edges of the skin and its use is particularly valuable in the suture of wounds on the face. Inflammatory reaction about this very fine silk is much less than that about horsehair and stitches of this material leave no unsightly suture marks on the face. It is difficult to work with because of its fine caliber. When this suture material is applied with the on end mattress stitch ideal approximation of the cutaneous margins may be achieved.

The use of the crêpe lisse dressing as advocated by Halsted (8) is a valuable adjunct in the post operative care of the wound (Fig. 8). This dressing consists of a patterned piece of indestructible chifon. The material is firm, inelastic and smooth. Impregnated with collodion it is applied directly to the surface of the skin or, if the wound be not completely healed, over a layer of silver foil. In my opinion, this dressing is an invaluable aid in limiting the stress on a sutured wound when it is in the early stages of healing and before its maximal tensile strength has been reached.

SUMMARY

In order to promote ideal cutaneous healing of wounds and minimal cicatrization the following points in the technique and suture of clean surgical wounds are emphasized: the importance of placing the long axis of an incision parallel to Langer's lines of elasticity of the skin whenever possible, attention to the technique of incision so that the incision into the skin is not beveled, adequate undercutting of the skin and subcutaneous tissue flaps so that tension on the cutaneous line of suture is minimized, the use of silk ligatures and sutures, and the use of fine arterial silk for approximation of the edges of the skin in the suture of wounds of the face.

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THE RATE OF EMPTYING OF THE HUMAN GALL BLADDER IN PREGNANCY

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SINCE von Recklinghausen's notable discovery (1880-1887) that 90 per cent of women having gall stones have been gravid at least once and the subsequent finding by Courvoisier (1890) that three times as many women have gall stones as men, pregnancy has been considered to be one of the major factors in the development of cholelithiasis.¹ With the advent of the Graham-Cole method of cholecystography (1924), certain other corroboratory facts became available: first, it was noted that in pregnancy the gall bladder visualizes more slowly (D'Amato and Gmelin, 1927; Clauser, 1929) and remains visible longer (Kalk and Schoendube, 1926; Clauser, 1929); second, that gall-bladder bile, as recovered from the duodenum after injection of pituitrin, is more concentrated in pregnant women than in others (Kalk and Schoendube); and, third, that the gall-bladder sediment of such individuals frequently contains small cholesterin crystals (D'Amato and Gmelin). These facts all seemed to point to the existence of a gestational biliary stasis, but Boyden's statistical studies of 1927-1937—showing among other things that, after puberty, the gall bladder empties more rapidly in women than in men (a sex difference that persists even unto old age, Boyden and Grantham, 1936)—have made it imperative that a statistical analysis of the rate of emptying of this viscus be made in pregnancy.

The first direct proof that gestation retards evacuation of the gall bladder in mammals must be attributed to Mann and Higgins (1927). Working primarily with the thirteen-striped gopher, a small rodent that could be examined in large numbers as it becomes pregnant upon emerging from hibernation,

¹For general substantiation of these figures and for more recent statistics of the incidence of gall stones in men and women, see Schaefer (1932).

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these authors found that while the non-gravid animal regularly exhibited an empty gall bladder 4 hours after a meal of egg yolk and cream, only slight emptying was observed in the early stages of pregnancy and that from the middle of pregnancy to term there was no evidence of emptying at all. Scattered observations on other laboratory mammals seemed to support this view, but Whitaker and Emerson (1928)—after roentgenographing 5 cats, 3 of which showed only moderate emptying at 2 to 4 hours postcibum, and 2 human cases (1 of which had 20 gall stones)—concluded that "pregnancy in itself exerts no inhibitory effect upon the emptying of the gall bladder."

Curiously enough, the earlier cholecystographical studies of pregnant women seemed to support this view. Thus Levyn and Aaron (1928) having visualized the gall bladder intravenously in 10 of 17 primiparae who had no history of biliary tract disease, reported that in these 10 individuals the response to the Boyden meal was prompt and that adequate diminution or complete disappearance of the shadow occurred during the first, second, and third hours after the meal. Incidentally, the first picture was not taken until the end of the first hour postcibum.

The next study, by Fogelson (1929), yielded similar conclusions. Employing the oral method, this author was able to visualize the gall bladder in only 15 of 43 pregnant women, but he reported that in these 15 the biliary vesicle emptied within the normal period (which the author does not define) following a fat meal of 2 eggs, half a glass of cream, and butter fat.

According to Schaefer, Dellepiane (1929) reported that in the second trimester the gall bladder empties even faster than normal.

Close upon these initial studies came three articles that supported the contrary view. In each case the intravenous method was used. First, Naegeli reported that in 23 primigravidae (5 to 9 months pregnant—mostly

women about 20 years old without any history of hepatic or cholecystic disease) the emptying of the gall bladder was markedly delayed in 70 per cent of cases, i.e., 50 to 60 minutes after ingestion of 3 egg yolks, emptying had "hardly begun" and after 6 to 8 hours, the gall bladder was little more than half full.

More detailed figures were given in a subsequent study by Westphal and Gleichmann (1930-1931). Using Bronner's rough method of inspecting the size of gall bladder shadows after a meal of 3 egg yolks¹—his normal criterion being that by 1 to 1¼ hours the area (?) of the shadow be, at most, only 1/6 or 1/7 the size of the shadow at the beginning of the meal—these authors found that 6 of the 18 women tested were normal (most of the 18 being primigravidae and pregnant from 1 to 5 or 6 months). The other 12 showed marked delay in emptying. Details are given of each case, but the data are in such approximate and inconstant form that it is not possible to obtain mean values of the rate of emptying.

The last of this series, by Schaefer (1933), involved a study of 29 healthy women, mostly primiparae in the second half of pregnancy. Of the 27 cases in which the gall bladder was visualized, no change in the size of the gall bladder was said to be noticeable 15 minutes after a meal of 3 egg yolks. This statement, however, is not confirmed by tracings of cholecystograms from 4 of the author's 27 cases, for in 3 of the 4 (see his Figs. 6, 10, and 14) there is a distinct reduction in size at the end of the first 15 minutes. Further, it was stated that "often" the gall bladder exhibited a large residue at 6 hours, and that "all" gall bladders showed delayed emptying. Except for the few illustrations no data were given for the 27 cases.

Surveying these articles, which fall into two contradictory groups, it is apparent that with the possible exception of Westphal and Gleichmann's study, conclusions have been based upon general impressions. No article, for in-

stance, supplies enough detailed information to construct a mean curve of emptying for the group studied. Yet in the absence of this no one seems to have resorted to the device of testing the same individual twice, that is, during pregnancy and then afterward. Nor do any of these studies provide adequate normal controls. Even Bronner's method of estimating the size of the gall bladder shadow at 1¼ hours postcibum falls far short of furnishing an adequate idea of the rate of emptying since normal gall bladders, on the average, empty two thirds to three fourths of their contents within the first 40 minutes after a meal of egg yolk and some empty all but a minute residue in 15 to 20 minutes (Boyden, 1928, etc.). Nor is the method of guessing at the size of shadows satisfactory. As an illustration of this we have computed the relative volumes of the gall bladder in the 1 case in which Westphal and Gleichmann present cholecystograms. Where these authors say that at 35 minutes postcibum (their Fig. 3, cholecystogram 2) there has been "no emptying," we find a volume loss of 11.5 per cent, at 95 minutes postcibum (their Fig. 3, cholecystogram 3) where the gall bladder is said to be "half full," the volume loss is 71.3 per cent, and at 155 minutes postcibum (their Fig. 3, cholecystogram 4) where the shadow is said to be "the same," the volume loss is 74.9 per cent, even if the 35 minute reading be considered as unity, there is still a loss in volume at the 95 minute reading of 67.6 per cent. Finally, it is not clear at what point in the cycle retardation in emptying occurs, if such be the case.

Accordingly, it has seemed desirable to apply to this important problem the same quantitative methods that have made it possible to detect sex and age differences in the reaction of the gall bladder to a standard meal as well as its differing behavior in such closely allied diseases as peptic ulcer and carcinoma of the stomach.

MATERIAL AND METHODS

The material upon which this study is based consists of cholecystograms of 21 healthy pregnant women, 13 of them primigravidae, most of the latter coming from insti-

¹This test meal known in Germany and Italy as Bronner's is a modification of the original Boyden meal. It recognizes the sensitivity of a discovery in 1923 that egg yolk is the natural food most potent in emptying the mammalian gall bladder—an observation which was extended by him, in 1925, to include the human gall bladder. In its crude form however egg yolk is unpalatable also the cream is formed, the other component of the original meal is not necessarily rich. Therefore, for many years the writer has used 4 egg yolks mixed with an equal amount of milk (the whole seasoned with a pinch of sugar and a drop of vanilla) as being the most satisfactory for the purpose.

tutions for unmarried mothers. With one or two doubtful exceptions each case was selected on the basis of a negative biliary and gastrointestinal history.¹

In view of the difficulties encountered by other investigators in visualizing the gall bladder of gravid patients, it was deemed advisable to use the intravenous method. The dye selected for this purpose was sodium phenoltetraiodophthalein, since it was considered by the Mallinckrodt Company to be less toxic than its more familiar isomer and to be effective in smaller doses. For each patient 2.5 grams were dissolved in triply distilled water, filtered through fine paper, and sterilized for 15 minutes in a boiling water bath. The intravenous set-up was such as to permit substitution of saline for the dye whenever expedient. The solutions were kept warm in a water bath and run in by the gravity method, over a period of from 30 to 50 minutes. In each case the dye was preceded and followed by 100 to 200 cubic centimeters of saline in order to avoid any possibility of thrombosis. Several patients complained of some pain in the arm at the time the dye was introduced, but pain did not follow the course of the vein and seemed to be due to the position of the arm on the arm board. In general no untoward results followed the use of the intravenous method.

For the purposes of this test, patients were admitted about 4:30 p.m. and hospitalized for the next 20 hours. At 5 p.m. they were given a light supper of tea and toast. The dye was then administered about 7 p.m. Later in the evening or early in the morning a high flushing enema was given. Twelve hours after the dye a preliminary roentgenogram was taken with the patient lying face down and supported with pillows and sandbags, the lower abdomen being screened to protect ovaries and fetus. If the preliminary picture was satisfactory the patient was then given the modified Boyden meal² and x-ray films made at 0, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, and 45 minutes postcibum. Subsequently, the chang-

ing volumes of the gall bladder were computed from the cholecystograms after the graphic method described in previous studies (Boyden, 1928; Boyden and Fuller, 1934).

VISUALIZATION OF THE BILIARY VESICLE

Of 21 patients that received the dye intravenously, only 2 failed to exhibit a shadow of the gall bladder. One of them, (V.H., age 23, weight 179 pounds, pregnant 8 months) was a primigravida with an essentially negative gastro-intestinal history. The other (E. G., age 24, weight 176 pounds, pregnant 5½ months) had been gravid 3 times, the current pregnancy being characterized by much belching and heartburn. It is probably not without significance that in both cases the weight of the patient was excessively high. In a third patient (A. S., age 20, weight 116 pounds, a primigravida, pregnant 2 months) the gall bladder was visualized well enough to warrant further study but it failed to empty, probably because the egg yolk was vomited immediately. A fourth case—a 43-year old multigravida (I. D.), not included in the 21—had gall stones.

Although it is difficult to compare these findings with other reports in the literature, since complete information about individual cases is rarely given, our degree of success in visualizing patients approximates that of Schaefer's (1933) rather than any of the others listed in Table A; i.e., through the first 7 months it was not particularly difficult to visualize the gall bladder of healthy gravidæ. On the other hand, it was noted that in 4 of the 5 patients observed both antepartum and postpartum (Table IC) the intensity of the gall-bladder shadow was greatly improved 6 to 8 weeks after parturition. (In the fifth case, E. H., it was distinctly fainter.) It is evident, therefore, that pregnancy does affect the degree to which the gall bladder is visualized even if it does not prevent it entirely.³

¹Among others, Benda also advances the theory that pregnancy affects the absorptive function of the gall bladder or the excretory function of the liver, but since he fails to state whether he used the oral or the intravenous method, his data cannot be compared, statistically, either with ours or with Schaefer's material. According to his preliminary account, he examined 46 healthy gravidæ, 9 in the first half, and 37 in the second half of pregnancy. In the former group all gall bladders were visualized. In the latter group, the gall bladder could be seen in only 12 of 22 primigravidae and in only 5 of 15 multigravidae. Eighteen of the 37 were examined in the puerperium. In 3, the gall bladder remained unvisualized as in latter half of pregnancy, in the other 15 it was visualized regardless of whether it had appeared in latter half of pregnancy.

²The authors are greatly indebted to Dr. J. C. Litzenberg, Chief of the Division of Obstetrics and Gynecology, for the privilege of working with these patients and to Dr. Leo G. Kugler, head of the Department of Radiology, for the use of x-ray facilities.

³Four egg yolks mixed with an equal amount of milk (the whole seasoned with a pinch of sugar and a drop of vanilla).

TABLE I—EMPTYING OF GALL BLADDER IN PREGNANCY

Patient	Age	Weight (pounds)	Months pregnant	Times pregnant	Volume at intervals after eating											
					5 minutes ccm	8 minutes		12 minutes		20 minutes		30 minutes		40 minutes		
						Ccm	Per cent loss	Ccm	Per cent loss	Ccm	Per cent loss	Ccm	Per cent loss	Ccm	Per cent loss	
A. 5 gravidae (1st trimester)	E D	21	86	4	III (2)	24 03	19 52	21 70	14 76	4 79	9 68	61 27	7 87	68 43	5 74	36 98
	D F	20	150	2 5	II (1)	45 9 (0 min)	41 30	10 00	28 50	37 91	19 80	56 87	17 50	61 37	15 60	66 00
	V M	22	112	2	I	27 06	(30 83)	00 00	(18 04)	00 00	19 00	20 72	0 0	65 66	5 74	28 70
	M No	37	135	2 5	IV (1)	112 0 (4 min)	78 88	30 57	54 45	51 30	43 13	61 49	30 03	65 15	30 18	73 05
	A R	33	156	3 5	III (2)	70 4	56 1	30 0	47 6	32 37	33 5	52 42	(37 7)	53 43	31 6	53 7
	127	124				156 06			81 27		162 46		26 74		314 53	348 54
Mean percent gel 14 in 5 gravidae (first trimester)									16 25		32 49		52 33		62 01	60 71
Mean percent age loss in 12 nulligravidae (Boyden & Fuller 1934)									27 2		34 7		56 7		66 4	73
B. 13 gravidae (2nd and 3rd trimesters)	A A.	21	149	7 5	I	25 58	(25 91)	00 00	(25 91)	00 00	(26 20)	00 00	13 18	48 9	11 81	53 81
	G A	17	122	6	I	31 47 (4 min)	30 50	5 14	30 10	4 45	27 47	28 67	17 38	41 83	14 27	54 7
	G C	10	110	7	I	30 0 (0 min)	(31 49)	00 00	28 37	5 43	2 5	31 67	23 30	55 67	9 84	87 20
	Z C	13	117	5 5+	I	42 15 (0 min)	35 30	16 25	30 7	27 16	21 48	40 04	18 30	56 8	(22 9)	56 82
	M F	23	189	5 5+	II (1)	38 05 (4 min)	35 30	7 23	33 10	13 00	20 85	21 55	24 76	34 93	21 48	43 35
	A G	16	154	8	I	31 32 (0 min)	(31 3)	00 00	(31 33)	00 00	20 50	5 82	26 73	14 06	24 11	23
	L G	20	130	6	I	35 26 (0 min)	(43 46)	00 00	(4 33)	00 00	(41 66)	00 00	33 30	5 56	25 47	77 91
	F H	15	133	4 5	I	33 30	33 13	51	32 64	1 98	32 40	5 44	30 5	8 41	26 00	10 22
	A L	21	131	6	I	35 02	34 93	2 76	30 67	14 62	21 00	47 54	(12 80)	41 54	(22 06)	41 54
	M N	0	15	7	I	38 22 (0 min)	24 93	34 76	(5 0)	34 76	21 50	43 73	16 10	57 90	15 33	59 3
	M Pa	33	193	5	V (11)	84 95 (0 min)	77 4	9 08	73 06	37	60 35	3 96	45 59	46 33	44 61	47 49
	M Po	19	164	7	I	47 3	38 35	8 74	4 5	48 05	14 10	70 5	11 15	76 30	8 55	81 90
	F S	4	11	6	III (6)	63 30 (4 min)	54 77	13 45	5 35	18 91	39 36	37 8	8 37	5 5	22 30	64 77
	120	1 50				141 20			05 95		364 39		547 3		621 18	
Mean percentage loss in 13 g v d e (2 and 3d trimesters)									8 75		13 97		8 3		4 09	49 3
Mean percentage loss in 22 null gravidae									17 2		34 7		56 7		66 4	73 2
C. 5 cases (postpartum)	A A	See above	11	I (1)	6 40	20 66	11 75	16 73	15 64	6 56	75 15	2 79	69 43	1 80	91 15	
	G C	See above	8	I (1)	22 30	18 86	5 43	4 0	33 0	0 05	53 18	7 70	65 47	5 41	75 74	
	A G	See above	6	I (1)	31 50 (0 min)	28 37	9 94	27 55	32 54	24 05	0 86	23 78	24 5	13 1	38 35	
	L G	See above	7	I (1)	5 96 (4 min)	31 82	1 46	30 0	8 08	23 70	20 34	75 50	5 08	33 23	60 19	
	E H	See above	8	I (1)	23 94	15 20	36 51	23 45	43 8	10 66	55 47	7 80	67 4	8 0	67 4	
					127 42		87 09		35 08		30 0		02 81		154 83	
Mean percentage loss in 5 women 6-8 weeks postpartum									7 42		27 08		47 24		59 06	70 93
Mean percent age loss in same 5 women at 5-8 mos.									0 10		1 45		8 50		6 61	5 4

*Considered as 100% substitute readings are noted in parentheses
 †A or B
 ‡Figures in parentheses indicate number of b lts
 §Weeks postpartum

TABLE A

Author	Method	Number tested	Number visualized
Levy and Aaron (1928)	Intravenous	17 primiparae	10
Crossen and Moore (1928)	Intravenous	13	7
Benda (1928)	Oral [*]	37 (2nd half gestation)	17
Fogelson (1929)	Oral	58	15
Naegeli (1929)	Intravenous	80	28*
Westphal (1930-31)	Intravenous	18 ⁷ (trimester 1-2)	15
Schaefer (1933)	Intravenous	29	27

*Indicates good series of cholecystograms, not test of visualization

RATE OF EMPTYING IN FIRST TRIMESTER

During the 2 years that these cases were being collected every attempt was made to obtain as many early pregnancies as possible, the only available source of supply being the Outpatient Prenatal Clinic of the University Hospitals. Unfortunately, most of those who came early in pregnancy were admitted for hyperemesis, pyelitis, or other complications that rendered the subject unfit for our purpose. Hence the material is limited to 5 healthy patients, 4 of them being multiparae. The individual curves of emptying are shown in Figure 1B. A glance at the last column of Table 1A shows that at 40 minutes after the standard meal, 4 of the 5 gall bladders had discharged from 66 to 78 per cent of their contents, as compared with the nulligravid mean of 73 per cent. The fifth case (A. R.) had been troubled with emesis and had vomited part of the meal between the 20 and the 30 minute pictures.¹ Even including this case the mean rate of evacuation for the first trimester is thus only a little slower than the rate for the nulligravid controls (Fig. 5A), the difference being not statistically significant.

EMPTYING OF THE GALL BLADDER IN THE SECOND AND THIRD TRIMESTERS OF PREGNANCY

For this period 13 healthy individuals were available, 10 of them being primigravidae.

¹We would interpret this cessation of emptying as being due to reverse peristalsis of the duodenum rather than solely, if at all, to a spasm of the sphincter of Oddi, because it has been shown in a cat that in spite of the fact that the gall bladder exerted enough pressure to inject the hepatic ducts, bile was unable to escape into the intestine while antiperistalsis of the duodenum was in progress (Boyden, 1926, Plate 1). Doubilet and Colp's recent statement that vomiting causes a spasm of the sphincter of Oddi (as determined by manometer studies made with the aid of T-tubes inserted into the human common duct) must therefore be accepted with reservation.

Detailed information about this group is given in Table 1B. The mean rate of emptying is indicated by the heaviest solid line in Figure 5A. When compared with the curve for nulligravid controls (lowest solid line in the same figure) there can be no doubt that in the second and third trimester, some factor in gestation has retarded the emptying of these gall bladders. Indeed, when submitted to statistical analysis it was found that there was not a single chance in a thousand that this difference could be due to random sampling. Even when the best 8 cases were averaged (for individual curves, see Fig. 1A) the mean curve showed retardation (asterisk, Fig. 5A). The most striking differences, however, appeared when the same individuals were tested during pregnancy and then afterward.

EMPTYING, 6 TO 9 WEEKS POSTPARTUM

It had been our intention to examine all pregnancy cases in the postpartum period also, but the unmarried status of most of these patients made it difficult to insure their return. In 5 cases, however, we were successful. As far as could be ascertained, these are the only instances in which the rate of emptying of the gall bladder during pregnancy has been checked by postpartum studies of the same individuals. Naegeli states that he did so once, but gives no further information.

When the two sets of curves of these primiparae are compared (Figs. 2 to 4), three significant observations can be made. First, the gall bladder exhibits marked recovery in its rate of emptying 6 to 8 weeks after parturition. At 40 minutes postcibum, for instance, the mean percentage of bile discharged by these 5 gall bladders is twice as great postpartum as during pregnancy (Fig. 5B). One would like to know exactly when this recovery takes place. We have not felt justified in disturbing the patient during the puerperium, but Schaefer (1933) reports a case in which pictures were made just before birth and continued from 2 to 4 hours after birth. The claim was made that immediately after birth emptying became normal, presumably because no shadow was observed at 120 minutes postcibum—perhaps it was diluted out by filling—but the cholecystograms made at 15

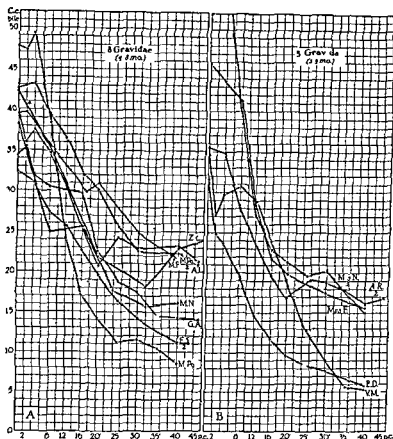


Fig 1 Individual curves of evacuation of gall bladder representing A cases of the second and third trimester that exhibited least retardation in emptying B 5 cases from the first trimester of pregnancy For original data see corresponding initials of patients in Table I Note that the slopes of the curves in the first few months (for the mean see next to lowest curve in Fig 5A) are steeper than those in the later months (for mean see asterisk Fig 5A) Cc bile volumes of bile in gall bladder as computed from cholecystograms 2, 4, 8 etc minutes after ingestion of standard meal (4 egg yolks and equal amount of milk flavored with sugar and vanilla) Curves designated by a fraction (viz $\frac{E.S.}{2}$) indicate that volumes have been plotted one half size

and 60 minutes postcibum, 1 e, between 2 and 3 hours after birth (his Figs 10 and 11) certainly show delayed emptying

The second observation is that in 3 of 5 cases the gall bladder is more distended during pregnancy than afterward (Figs 2A, 2B, and 4A) Potter (1936) found 75 per cent distended in a series of 390 cesarean sections at term

Third, retardation seems due primarily to an initial delay in emptying (compare mean curves of these 5 cases, Fig 5B), 1 e, to a fail

ure of the gall bladder to empty at the time when the passage of egg yolk into the duodenum should induce the greatest discharge of bile, namely during the first 20 minutes of a phase of emptying that averages only 32 minutes (Boyden, 1928)

Although we have studied only the first phase of emptying, which is always the most important, there is every reason to suppose that the lesser secondary phases would react the same way, the accumulated effect being then detectable at $1\frac{1}{2}$ hours postcibum, the

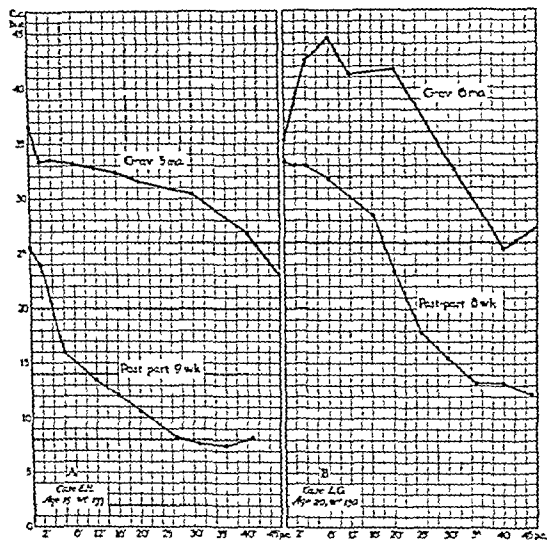


Fig 2 Individual curves showing evacuation of gall bladder at different times in same patient. Note that the gall bladder is more distended and that its rate of evacuation is more retarded during pregnancy than after parturition (Other legends as before)

time at which Westphal and Gleichmann made their observations

THE CAUSE OF DELAYED EMPTYING IN PREGNANCY

Among the numerous reasons advanced to account for ineffective discharge of bile in pregnancy is mechanical pressure exerted upon the biliary tract by the expanding uterus. But, Westphal and Gleichmann have pointed out that this does not become excessive until the late months of pregnancy. Since these authors found only partial emptying at $1\frac{1}{2}$ hours in patients gravid less than 6 months, they were probably justified in assuming that mechanical pressure was not the primary factor in this stasis of the gall bladder. Mann and Higgins also observed that when they placed small balls of paraffin inside the abdomen of gophers, to simulate the distention of pregnancy, the gall bladders of these animals emptied normally. It is instructive to note, however, that in the 4 patients in whom the gall bladder had been pushed into a horizontal position at the level of the tenth to twelfth ribs (Z C, A. G., L. G., and M. Pa., Table IB), the rate of emptying had been re-

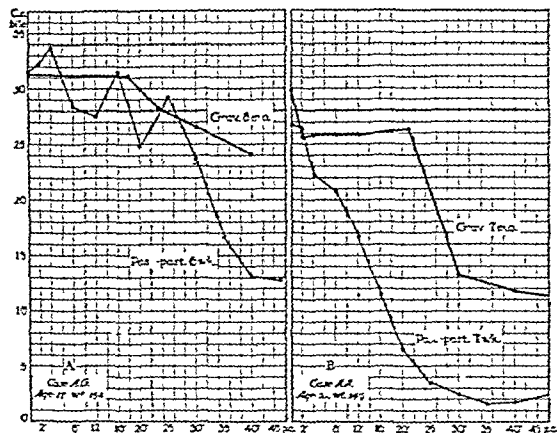


Fig 3 Additional cases contrasting rate of emptying of gall bladder in antepartum and postpartum periods.

tarded. Position and pressure may, therefore, be contributory factors.

To test the matter, experimentally, we planned to study the rate of emptying in a series of myomatous women in whom tumors of the uterus were large enough to reproduce the mechanical pressures of the third trimester of pregnancy. Unfortunately we were able to obtain only 1 such uncomplicated case for study, but the evacuation of the gall bladder in this patient even exceeded the mean normal rate (Fig. 4B); for 81 per cent of its contents had been discharged by the 40 minute reading, notwithstanding the fact that

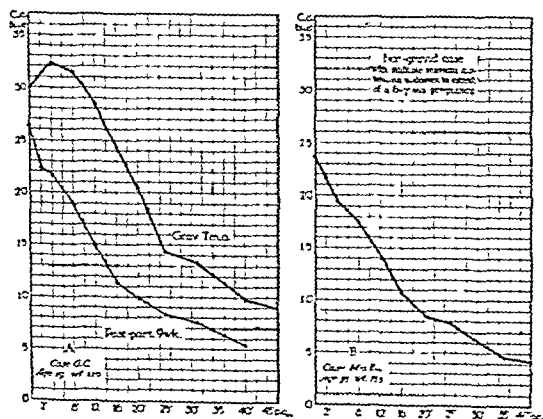


Fig 4 Individual curves contrasting effect of pregnancy with a purely mechanical distention of the abdomen caused by tumors of the uterus. For cholecystograms of Mrs. B., see Figure 6

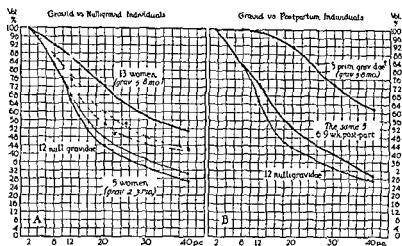


Fig 5 Mean curves of evacuation of gall bladder of pregnant women reconstructed from data in Table I Vol % percentage of bile in gall bladder at a given time the volume at 2 minutes after the standard meal (when the gall bladder first goes into tonus) being reckoned as unity, 8, 1, etc minutes after standard meal

*Those 8 of the 13 gravid cases that showed 1st delay in emptying after a standard meal

**The 5 of the 8 that were nearest normal

†Those 5 of the 13 gravid cases that showed most delay in emptying

the tumor measured 20 by 14 by 8 centimeters (with a weight of 1200 grams) and was palpable three fingers above the umbilicus. From these figures it may be inferred that the uterus corresponded in size to that of a 7 months' pregnancy. Incidentally, the gall bladder of this patient contained a transverse congenital septum (Fig 6) not unlike that which occurs a little lower down on the gall bladder in cases of the folded fundus. But as pointed out in a previous study of the "Phrygian cap" (Boyd, 1935) such septa do not retard the rate of emptying any more than other congenital folds that occur normally in the neck and duct of the gall bladder.

It is apparent, then, that one must look for some deeper seated explanation of the biliary stasis of pregnancy, namely to a spastic condition of the sphincter of Oddi as first described for pregnant women by Westphal (1923).

This investigator observed that, when the gall bladders of non pregnant individuals were made to contract by injecting 30 cubic centimeters of a 5 per cent solution of peptone into the duodenum the amount of gall bladder bile being aspirated could be increased by intravenous injection of pilocarpine the

theory being that pilocarpine acted like a weak vagal stimulation in accelerating the contraction of the gall bladder musculature. When, however, the same procedure was tried on 10 women who were gravid 3 to 9 months (and 4 non gravidæ that were menstruating) the initial effect of pilocarpine was to inhibit the flow of bile for a period ranging from 3 to 20 minutes, following which there ensued a rush of dark bile. Westphal explained this initial inhibition of emptying by the assumption that in gestation the organism was already under increased vagal stimulation—as evidenced by such characteristic disorders of pregnancy as salivation, hyperemesis, and a tendency toward diarrhea—so that when pilocarpine was given it acted like a strong vagal stimulation (in animal experiments) and therefore produced at first a spasm of the sphincter of Oddi.

Undoubtedly Westphal has come very close to the probable explanation of this physiological aberration. At least he must be credited with having reproduced experimentally, by the use of peptone and pilocarpine, a comparable reaction to that which frequently occurs when egg yolk is ingested by pregnant women—namely, a prolonged initial delay in

the emptying of the gall bladder following what would normally be an excitatory stimulus¹

But whereas Westphal would attribute this longer pause of pregnancy to a "disharmony" of the autonomic nervous system, i.e., to a *hypertonische motilitäts-neurose* induced by the modified functions of the hypophysis, ovary or other endocrine organs—we would suggest that such a dyskinesia may be due equally well to the effect of hormones of pregnancy acting directly upon the musculature of the bile duct. It has long been known, for instance, that they inhibit the rhythmic contractions of the uterus. In thus preventing premature expulsion of the fetus they may produce imbalance in other muscular tubes. Especially is this true of the ureters, the musculature of which, incidentally, originates at the same fetal period as the sphincter of Oddi (Schwegler and Boyden). Apparently these changes affect the upper and lower portions differently, even as the latter have a differing innervation and are said to react differently to pituitrin. Thus the section above the pelvic brim undergoes an atonic dilation which Traut and McLane have recently shown to be characterized by progressive diminution of peristaltic activity from the third to the seventh month, after which the upper ureter begins to recover its activity. The muscle around the juxtavesical portion, however, undergoes an hypertrophy that results in constriction of the lower ureter (Hofbauer, 1928). Similarly the hormones of pregnancy may increase the tone of the sphincter of Oddi.²

Furthermore, there are other serious objections to applying to the human biliary tract, without qualification, Westphal's deductions from animal experimentation. In the first place we have seen no convincing evidence

¹Incidentally, Westphal frequently observed in non-gravid individuals a short delay in emptying, after pilocarpine, which he interpreted to be the initial response of the sphincter to stimulation. This probably corresponds to what one of us has described as the "two-minute pause" in the curve of emptying. It is not constant, but occurs so frequently as to be considered, perhaps, the typical reaction (see Fig. 3, Boyden, 1928). By the use of numerous cholecystograms it is possible to show that it usually appears not simultaneously with the ingestion of food but immediately after the gall bladder first goes into tonus. On the basis of McMaster and Elman's manometer studies on dogs (1926), this temporary interruption to emptying has been attributed to that increase in tone of the sphincter which commonly appears 2 minutes after ingestion of food.

²Some, indeed, might consider that there is a closer parallel between the response of the ureter and extrahepatic biliary tract to pregnancy, namely, that the gall bladder undergoes atony at the same time that the sphincter increases its tone. But we have seen no indication that the gall bladder of pregnancy is atonic.

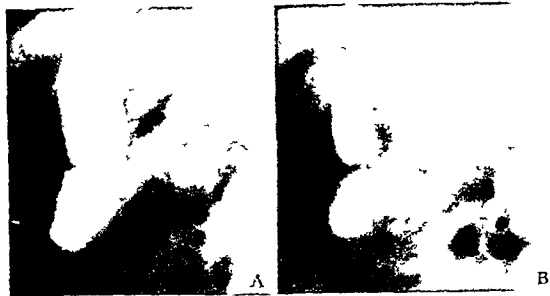


Fig 6 Two cholecystograms from Case Mrs. Bu showing unusually placed congenital septum of a nature similar to that found in cases of folded fundus (the so called "Phrygian cap"). In spite of this anomaly and a mechanical distention of the abdomen equivalent to a 7 months' pregnancy, the gall bladder emptied normally (see text and curve in Fig. 4B). A, cholecystogram taken at 2 minutes postcibum, B, at 25 minutes postcibum

that emptying of the gall bladder in man (as contrasted with that in laboratory mammals) is under control of motor nerves. On the contrary there is justification for believing that such control is minimal, perhaps restricted merely to tonus changes; for distention of the human duodenum with air or water, or the smell of food, merely produces changes in volume of the gall bladder comparable to the first tonus changes after food, i.e., it results in taking up the slack in the wall but does not result in discharge of bile (Boyden, 1928).

Even more illuminating, however, are the experiments with faradic stimulation of the gut. In the cat, for instance, it is possible to inhibit the emptying of the gall bladder abruptly by tetanizing any portion of the intestinal tract (Birch and Boyden, 1930). In man, however, no such reflexes passing from the digestive tube to the gall bladder can be demonstrated. The gall bladder continues to empty, in response to the mere presence of egg yolk in the small intestine, in spite of severe colic-like pains emanating from induced spasms of the gastric or duodenal musculature (Boyden and Rigler, 1934).

Turning now to the sphincter of Oddi, the musculature of the human bile duct is strikingly different from the sphincter of the guinea pig and rabbit upon which Westphal has based his theory of biliary dyskinesia (Boyden, 1937). In the guinea pig, for instance, there is a musculature of the ampulla (Westphal's

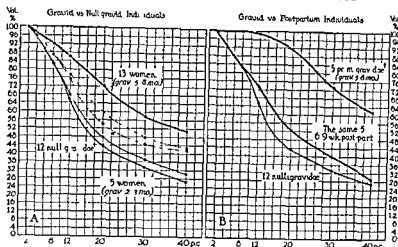


Fig 5 Mean curves of evacuation of gall bladder of pregnant women reconstructed from data in Table I of % percentage of bile in gall bladder at a given time the volume at 2 minutes after the standard meal (when the gall bladder first goes into tonus) being reckoned as unity 3 8 12 etc minutes after standard meal

*Those 8 of the 13 gravid cases that showed least delay in emptying after a standard meal

**Those 5 of the 8 that were pre-rent normal

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the tumor measured 20 by 14 by 8 centimeters (with a weight of 1200 grams) and was palpable three fingers above the umbilicus. From these figures it may be inferred that the uterus corresponded in size to that of a 7 months' pregnancy. Incidentally, the gall bladder of this patient contained a transverse congenital septum (Fig 6) not unlike that which occurs a little lower down on the gall bladder in cases of the folded fundus. But as pointed out in a previous study of the "Phrygian cap" (Boyden, 1935) such septa do not retard the rate of emptying any more than other congenital folds that occur normally in the neck and duct of the gall bladder.

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mal nulligravid mean of approximately 73 per cent

Even more significant is the comparison of the rate of emptying in the same individual before and after parturition. The mean discharge at 40 minutes postcibum in 5 patients subjected to this test, was only 38 per cent during pregnancy as against 71 per cent, 6 to 8 weeks postpartum.

On the basis of Westphal's peptone and pilocarpine experiments with gravid women, this initial delay in the response to a motor meal is attributed to a hypertonic condition of the sphincter choledochus, i e., to a physiological dyskinesia reflecting the changed hormonal content of the organism in pregnancy. The evidence indicates that this delay is a lengthening of the normal "2-minute pause" that usually occurs immediately after the first rise in tonus of the gall-bladder wall following ingestion of food.

The resulting biliary stasis accounts for the distended gall bladders found at term in 75 per cent of Potter's large number of cesarean sections and for the thick, tarry contents of gall bladders at term which are characterized by a low bile-salt (and a high cholesterol) concentration that is comparable only to that found in vesicles with a damaged wall. In conclusion it is believed that the stasis of pregnancy sets the stage for the sequence of events which results in the greater incidence of gall stones among women that have borne children

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"antrum") and a musculature of the duct of the ampulla (his "sphincter papillæ"). The peristaltic and expelling activity of the former he compares to the action of the pyloric portion of the stomach and the latter to the pyloric sphincter. In his pilocarpine experiments it is the former that first undergoes spasm and then expulsive activity. In man, on the contrary, there is no division of the muscle of the ampulla into proximal and distal parts. Indeed, the ampulla of Vater is rudimentary and the principal muscle of the duodenocholedochal junction is the sphincter choledochus which encloses the pre ampullary portion of the bile duct (Schwegler and Boyden, 1937). Due to the incompleteness of its longitudinal coat it cannot have any peristaltic function. Therefore Westphal's elaborate theory of antral and sphincteric segments, under respective control of parasympathetic and sympathetic nerves, breaks down when applied to man, notwithstanding Aschoff's gratuitous transference of the guinea pig terminology to the human sphincter in 1923. We do not mean to imply, however, that the human sphincter choledochus may not be under nervous control. Whether it is primarily regulated by hormones or the autonomic system, or both, has yet to be proved. Nevertheless, Westphal's notable demonstration that the initial interruption in the flow of the bile—our "two minute pause"—is greatly prolonged in pregnancy, points clearly to the existence of a gestational hypermotility of the sphincter choledochus.

THE RELATION OF PREGNANCY TO CHOLELITHIASIS

From this account it is clear that in the second and third trimesters of pregnancy the emptying of the gall bladder is markedly retarded during the first part of a phase of contraction that has been induced by the most potent food known to activate the gall bladder musculature. It inevitably follows from this that the biliary vesicle must accumulate stagnant bile during the period of gestation—the degree of stasis varying with the individual. Direct confirmation of this basic fact has recently been supplied by Potter (1936). First, he observed in 390 cesarean sections of preg-

nant women at term that approximately 75 per cent of these supposedly healthy individuals had a large globular, distended gall bladder. Second, an analysis of the contents of 58 of these biliary vesicles, withdrawn through a sterile needle at the time of section showed a raised cholesterol and a surprisingly low bile salt concentration—the latter comparable to that found only in a damaged biliary vesicle. The fact that none of these 58 gall bladders contained gall stones, however, does not militate against the possibility that in pregnancy the stage is set for the precipitation of cholesterol. While Neuman (1931) and Andrews et al (1932) have stressed the importance of the lowered bile salt content, Walsh (1933) reached the conclusion that altering the interrelationship of either the cholesterol, fatty substances, bile salts, or acids in the gall bladder alters the ability of the bile to hold cholesterol in an aqueous solution. The sequence of events might therefore be postulated as follows: Stasis resulting at first in an increasing concentration of bile salts with resultant damage to the gall bladder wall, alters the concentrating power of the mucosa and thereby changes the normal ratio of the constituents of the bile. If metabolic disturbance or infection be then superimposed upon stasis precipitation of stones might well follow.

SUMMARY

Detailed cholecystographic studies of 21 healthy gravid women following intravenous administration of iso iodeikon, have shown that while the gall bladder could be visualized in 18 of them (85 per cent), 4 of the 5 that were tested both antepartum and postpartum exhibited improved concentration of the dye 6 to 8 weeks after parturition. This finding points to a gestational alteration in the concentrating power of the gall bladder wall.

The rate of emptying of the gall bladder—as tested by the modified Boyden meal—is not significantly different from the normal rate during the first 3 months of pregnancy, but in the second and third trimesters there is a marked retardation in flow, the mean discharge in 13 cases being only 52 per cent (at 40 minutes postcibum) as against the nor-

KRUKENBERG TUMORS OF THE OVARY

Clinical and Pathological Study of 21 Cases

EMIL NOVAK, M D , F A C S , and LAMAN A GRAY, M D , Baltimore, Maryland

THE literature of Krukenberg tumors is not very extensive, especially when one considers that this tumor type has been recognized for more than 40 years. From time to time single cases, or small groups of cases, are recorded, and, since the tumor represents the most interesting type of metastatic ovarian cancer, it has received much attention in numerous papers dealing with secondary ovarian cancer, especially in the discussion of routes of dissemination from the primary focus to the ovaries. There are only a small number of American contributions to the literature of Krukenberg tumors, among which may be mentioned those of Major, Fallas, Jarcho, Hundley, and Andrews.

What is a Krukenberg tumor of the ovary? It is probable that the concepts of many gynecologists and pathologists on this point are rather vague. The term should be limited to the pathological entity described by Krukenberg in 1896, making allowance only for this author's misinterpretation of its real nature. The tumor was originally described as a sar-

coma ovarii mucocellulare carcinomatodes, but Krukenberg's description of its gross and microscopic pathological characteristics was otherwise quite accurate. The marked stromal reaction often seen, and in a minority of cases even suggesting sarcoma, together with the sparseness of the epithelial elements in many cases, led Krukenberg into the error of designating these tumors as sarcomas. This mistake was corrected by Schlagenhauser in 1902, and this author deserves the credit for establishing the epithelial origin of these growths, and for demonstrating the fact that in most instances they are secondary to carcinoma elsewhere, most often in the gastro-intestinal tract. This latter fact is responsible for the loose concept of some authors that all ovarian cancers secondary to gastro-intestinal cancer are Krukenberg tumors, which becomes apparent if one analyzes the cases in the literature. The definition must be much more circumscribed than this, and, if we are to continue this eponymic designation, should be limited only to those tumors, whether secondary or primary, which assume the characteristics first described by Krukenberg.

From the Department of Gynecology, Johns Hopkins Medical School

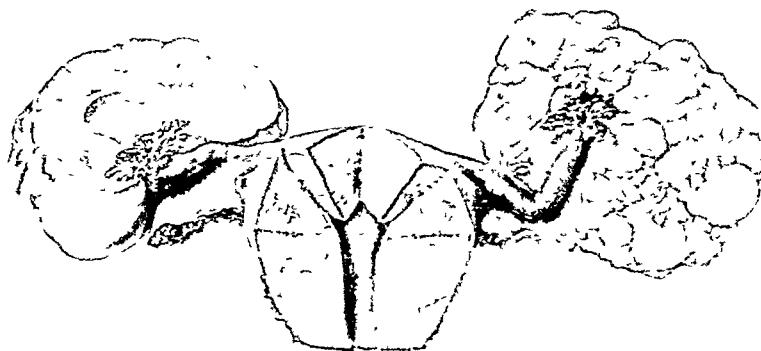


Fig 1 Gross appearance of bilateral Krukenberg tumor secondary to pyloric cancer (Case 21). Patient, aged 45 years, had had gastric resection 2 years previously (see Figs 2 and 3)

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From the Department of Gynecology, Johns Hopkins Medical School



Fig. 1. Gross appearance of bilateral Krukenberg tumor secondary to pyloric cancer (Case 21). Patient, aged 45 years, had had gastric resection 2 years previously (see Figs. 2 and 3).



Fig 2

Fig 2 Infiltrating carcinoma of stomach wall in Case 21

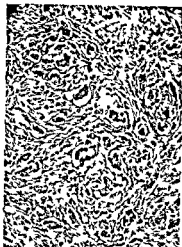


Fig 3

Fig 3 Ovarian metastasis in Case 21



Fig 4

Fig 4 Krukenberg tumor in Case 3 secondary to gastric cancer shown in Figure 5

What are the characteristics, gross and microscopic, which entitle a tumor to inclusion under this designation? Grossly such tumors are firm solid growths, usually of moderate size, almost always bilateral and retaining the general shape of the ovary (Fig 1). They are therefore rather kidney-shaped though not infrequently moderately

lobulated. External surface is smooth, with well developed firm capsule, with no tendency to become adherent to surrounding structures. On section, cut surface commonly of rather variegated appearance, some parts being quite firm others finely spongy, still others degenerated hemorrhagic or cystic, while areas of gelatinous appearance are common.



Fig 5

Fig 5 Infiltrating carcinoma of stomach in Case 3



Fig 6

Fig 6 Photomicrograph showing transition from definitely adenocarcinomatous areas to those which have a



Fig 7

more typically Krukenberg appearance (Case 12)

Fig 7 High power of Figure 6 showing profusion of typical signet cells

This variegation in the gross appearance of the cut surface parallels and is due to corresponding differences in the microscopic structure in different parts of the tumor. The stroma in some parts may be firm and richly cellular, while in other areas it is edematous or genuinely myxomatous, as we shall presently discuss. In Krukenberg's original paper, and in most of those which have been published since then, stress has been laid upon the sarcoma-like character of the stroma, the feature which led Krukenberg into his error of classifying this tumor as sarcoma. We have not been impressed with the importance or frequency of this supposed sarcoma-like stromal reaction. Indeed, there is no case in our series in which the suspicion of sarcoma would seem justified by the stromal reaction to the epithelial growth.

The epithelial elements may occur as clusters of well marked acini, though always, in the true Krukenberg tumor, showing various degrees of mucoid epithelial change. Often this is so extreme that the epithelial cells are completely melted down, leaving only the shadows of the original gland framework. The mucoid material may break through the gland wall and permeate the surrounding stroma, so that differential staining may reveal mucin not only in the glands but also in the stroma. In still other parts of the



Fig 8 Gross appearance of unilateral Krukenberg tumor in Case 9. Inset shows primary annular carcinoma of colon.

tumor the original gland pattern may be entirely blotted out, though small clumps or strands of epithelial cells may be scattered here and there in the stromal fields (Figs 2, 3, 4, 5, 6).

The mucoid changes described explain the occurrence of usually large numbers of signet cells, in which the nucleus is flattened out against the cell wall by the accumulated secretion within the cell (Fig. 7). It is these



Fig 9 Microscopic appearance of primary adenocarcinoma of colon in Case 9.



Fig 10 Disintegration of gland epithelium (Case 9). Adjoining areas show typical Krukenberg appearance.



Fig 11

Fig 11 Primary non mucoid adenocarcinoma of sigmoid in Case 8 (see Fig 12)

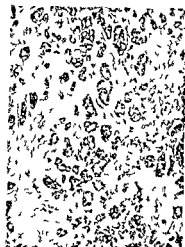


Fig 12

Fig 12 Krukenberg tumor in Case 8 showing in some



Fig 13

fields the presence of a moderate number of signet cells.
Fig 13 Primary Krukenberg tumor of ovary (case of Dr C J Andrews Norfolk Virginia)

cells which have been most stressed in the microscopic diagnosis of these tumors, and which have suggested for them the very apt designation of carcinoma mucocellulare

The frequent persistence of adenocarcinomatous areas makes the classification of some cases rather difficult, for all gradations may be seen between tumors which must be designated simply as secondary adenocarcinoma, with more or less mucoid tendency to tumors in which all trace of acinous structure is lost. In other words, one finds transitional pictures which suggest the Krukenberg tumor may be only the end product of a mucoid adenocarcinoma which in the environment of the ovary assumes the features which we look upon as characteristic of the Krukenberg tumor. Our Case 9 is a good example of this group (Figs 8, 9, 10). In this patient the primary lesion was a mucoid carcinoma of the ascending colon. The ovarian tumor shows in many places a typical mucifying adenocarcinoma but in others the picture is entirely typical of the Krukenberg tumor both grossly and microscopically. Signet cells are seen in large numbers. We have felt justified in including this with several other cases of the same general type, in our series.

In still other cases the tendency to mucoid changes has been much less striking though present to some degree, and yet there has been the characteristic grouping of the epithelial elements in small clusters of tiny acini, or of epithelial cells, together with the characteristic stromal picture of Krukenberg tumors. Case 8 is an example of this type of tumor and this, together with several others of the same general character, we likewise believe should be included in our group of Krukenberg tumors (Figs 11 and 12).

These, then are the characteristics of the Krukenberg tumors in the proper sense of the term. From what has been said it would seem that this neoplastic type is brought about by the development of a primarily mucoid adenocarcinoma in the ovarian environment or by the acquisition of mucifying tendencies by metastatic tumors which at their original site give no indication of mucoid characteristics. Such a course is certainly not the invariable one pursued by gastro intestinal cancers metastasizing to the ovary for the great majority of such secondary growths develop as non mucoid carcinomas with the usual pattern of adenocarcinoma so that they can not properly be considered Krukenberg tumors.

Raiford found that only 11.8 per cent of gastric carcinomas show the presence of mucoïd material; for the small intestine the proportion is 14.3 per cent, the colon 30 per cent, and the rectum 24 per cent. This author distinguishes between "mucoïd carcinoma," a malignant growth rising from the mucin-forming elements, and "adenocarcinoma with mucoïd degeneration," characterized by the development of mucous deposits in a pre-existing adenocarcinoma. In the first group there would seem to be little doubt that the presence of the mucin is explainable as a result of hypersecretion of the tumor cells, and the same explanation would probably also apply to the second group, rather than that the mucoïd change represents a degenerative process, as some have suggested. In any event, our own material indicates that the Krukenberg tumor may be secondary to gastro-intestinal carcinoma of either of the two types named, and that, as a third possibility, the mucoïd changes may develop in the originally gastro-intestinal carcinoma only after its transplantation to the ovary.

When the primary gastro-intestinal tumor is of mucoïd type, it is natural to expect the ovarian metastasis to have the same characteristics. On the other hand, in a considerable number of reported cases, as well as in a number of our own, the primary tumor shows no suggestion of mucoïd change. Scirrhus carcinomas, and even linitis plastica, have constituted the primary foci in many cases in which, when transplanted to the ovary, the growth has developed highly mucoïd characteristics. After all, this need not be wondered at, for mucoïd changes are frequently noted in scattered areas of gastro-intestinal cancers of primarily and dominantly non-mucoïd type, not only of the gastro-intestinal tract but also of the gall bladder or breast, either of which may constitute the primary seat of the malignancy in Krukenberg tumors.

While the primarily epithelial histogenesis of the Krukenberg tumor has now been firmly established, there remain two moot questions which have been extensively discussed in the literature. The first of these deals with the route of dissemination of the

cancer from the primary seat to the ovary. There is very little direct evidence on this point, the opinions of authors being almost entirely based on their concepts of cancer dissemination in general, together with certain circumstantial evidence available on this particular problem. There are four possible routes to be considered: viz, (1) direct implantation on the ovarian surface of cancer cells, transported by the peritoneal fluid from the primary lesion into the pelvis; (2) lymphatic metastasis; (3) transportation of cancer cells by the blood stream; and (4) extension of cancer by direct continuity from an adherent intestinal cancer. The possibilities, therefore, are, with the exception of the first, the same as those which must be considered in the explanation of secondary carcinoma in other organs, though it is of interest to stress that direct implantation, considered to be of little numerical importance elsewhere, is credited by many authors as being by far the most important factor in the spread of gastro-intestinal cancer to the ovary. This explanation was first suggested by Bucher in 1893, and it has been adopted by many, probably the majority, of writers on this subject!

According to this view, carcinoma cells penetrate the wall of the stomach to the peritoneal surface and are then directed downward by the peristaltic movements of the intestines, this transportation being facilitated by the peritoneal fluid. In the pelvis they encounter the ovarian surfaces, which are presumably rendered peculiarly prone to implantation because of the portals created by ovulation. It will be seen that this interesting viewpoint embodies a number of premises which are unproved and practically unprovable. Some of them, moreover, lack the ring of plausibility.

Even very tiny lesions of the pylorus, not discoverable except on microscopic examination, have in some cases been associated with Krukenberg tumors of the ovary. It seems difficult to believe that in such cases cancer cells make their way to the serosa, and that a purposeful peristalsis carries them downward for ovarian implantation, without their planting themselves on the intestines, parie-

tal wall, or other structures which are known to be vulnerable to implantation in other forms of abdominal cancer. Moreover, if our ideas of ovulation are correct, the rupture of the follicle occurs through a very minute opening which is quite effectively sealed off in a short time, probably not over a few hours.

Again, if implantation were the usual route for this extension, would one not expect to find the growth primarily on the ovarian surface? As a matter of fact, Krukenberg tumors are characteristically enclosed in a dense, smooth capsule, with no sign of surface growth. All this reasoning is obviously theoretical, but it at least throws serious doubt upon the importance of the factor of implantation in the origin of Krukenberg tumors. Indeed, there is an increasing skepticism among pathologists as to the importance and frequency of cancer produced by this mechanism, though none, so far as I know, denies its possibility. On the other hand, the evidence indicates that such instances of "contact cancer" as are observed on the lips or on the vulvar labia can be much more adequately explained on the basis of lymphatic extension. The same statement applies to the cancer of the pleura which is not infrequently associated with cancer of the lung (McCallum).

After all, the route of cancer dissemination which the studies of many years have established as by far the most important one for carcinoma in general is that by way of the lymphatic system. It is upon this concept that the surgical treatment of cancer is in large part based. And here the evidence available in many special fields, like that of the breast or the uterus, is indubitable. It would seem that the burden of proof should be placed upon any explanation of the origin of Krukenberg tumors which departs from this underlying concept, especially when the attempt is made to apply it as a universal rule. It must be admitted that the direct evidence on the importance of the lymphatic route in the explanation of the origin of Krukenberg tumors is very meager, and that it is harder to secure than in other fields of cancer investigation. In another form of secondary ovarian cancer, that associated with uterine adenocarcinoma, the lymphatic

route is strongly suggested by the finding in grossly normal ovaries of small cancer nests in the lymphatics of the hilum, as shown in a previous paper by one of us (Novak).

The retroperitoneal glands, which are involved in most cases of pyloric and other forms of gastro intestinal cancer, are closely linked up with the lumbar glands, into which the ovarian lymphatics drain. Involvement of the lumbar glands in cases of Krukenberg tumor associated with pyloric cancer has been reported by Amann, but there has as yet been no very convincing demonstration of the transportation of cancer cells from the stomach, via the retroperitoneal and then the adjoining lumbar glands, to the ovarian lymphatics and then the ovary. This explanation obviously invokes the retrograde method of lymphatic dissemination, but the possibility of this has been well established and is accepted by all pathologists.

The fact that Krukenberg tumors are bilateral in nearly 90 per cent of the cases would suggest that the invading cancer cells reach the ovaries from a common distributing point having equal access to both organs, and the lumbar glands naturally suggest themselves as this distributing focus. The further fact that Krukenberg tumor, as well as most other types of ovarian cancer, is much more apt to involve the other ovary than any other pelvic or abdominal viscus makes this route seem the likely one.

With reference to the possibility of metastasis to the ovaries by way of the blood stream, there would seem to be no doubt, though here again the lack of real evidence makes it necessary to depend upon such evidence as is furnished by cancer characteristics in general. There are some, like Ribbert, who believe that blood stream transportation more often explains Krukenberg tumors than does lymphatic dissemination and it is possible that this is the correct view. Certainly this seems probable as regards the occasional cases following breast cancer, though even here one can not eliminate the possible importance of the lymphatic route.

Little need be said as to the few cases in which the ovarian involvement has been explainable by direct extension from a gastro

intestinal carcinoma, usually in the rectum or sigmoid, which has become adherent to the pelvic organs, so that direct extension into the ovaries was possible.

The second moot point regarding Krukenberg tumors is as to whether these neoplasms are invariably secondary or whether in the occasional case they may be primary. As to the secondary nature of the overwhelming majority there can be no question, and yet there is a small group of cases in the literature in which it is difficult to escape the conclusion that in rare instances a primary ovarian cancer may conform in all respects to the definition of a Krukenberg tumor. Evidence based on operative findings is clearly of little value, as a primary pyloric carcinoma may be so minute as to escape detection by palpation, and there is always a possibility that small undiscoverable tumors may be present in some other part of the gastro-intestinal tract or in the gall bladder. Even at autopsy, such small primary growths may be missed, and conclusions based on any but the most complete and careful autopsy records are not valid in the assumption of a primary origin of the ovarian tumor.

There are, however, several cases in the literature in which these specifications have apparently been fulfilled, and in which the evidence for a primary origin seems very strong. Among these may be included the cases of Schenk, Glockner, Sternberg, Frankl, Neumann, and Andrews. In most of these the evidence has consisted chiefly in the apparent elimination by postmortem studies or carcinomatous lesions elsewhere in the body. Microscopic examination of the stomach must be included, though this was not done in Schenk's case.

There is, however, another type of evidence which would seem to justify the conclusion that a Krukenberg tumor may be primary in the ovary. If such a tumor conforms pathologically and histologically in all respects to the Krukenberg variety, and if careful clinical study as well as examination at operation fail to reveal any other tumor elsewhere, the assumption of primary ovarian origin would seem justified if the patient remains free of symptoms for a term of years after the opera-

tion. So far as we know, no case of Krukenberg tumor of the common secondary type has been cured by the operation, death usually occurring within a comparatively short time, most often from the primary gastric lesion.

In at least two reported cases, those of Andrews and Frankl, the requirements just mentioned appear to have been met. Through the kindness of Dr. Andrews, we have had the opportunity of studying his tumor pathologically, and we agree with him that it is a typical Krukenberg growth, from both a gross and a microscopic standpoint. Dr. Andrews was good enough to have one of us (Novak) study this case clinically also. There was no evidence of any digestive disturbance, and a thorough study of the gastro-intestinal tract, including roentgenography, was negative. The operation was performed in 1933, and a recent letter from Dr. Andrews states that the patient is in excellent health, with no suggestion of recurrence 4 years after operation, and no evidence of carcinoma in any other organ. In such a case a skeptic would be justified in questioning the accuracy of the pathological diagnosis, but both the gross and microscopic findings in the original ovarian tumor, and their comparison with other typical Krukenberg tumors, would seem to offer no loop-hole in this regard.

A somewhat similar case has been reported by Frankl, whose patient was well $3\frac{1}{4}$ years after removal of Krukenberg tumors of both ovaries, with no gastro-intestinal symptoms and with negative x-ray findings. A third case may perhaps be added, that of Neumann, though this seems less convincing. In this case the ovarian tumor, described as of Krukenberg type, was only partially removable. Careful palpation of the liver, stomach, and intestine showed no evidence of tumor, and no gastro-intestinal symptoms developed after operation. Seven years later the patient returned with a solid tumor mass filling the pelvis, but still with no evidence of a gastro-intestinal lesion. Palliative treatment with x-ray was begun, and 9 years after operation the patient was still living and in comparatively good general health, with still no indication of gastro-intestinal cancer though the pelvic tumor was still present.

There are, after all, certain histogenetic possibilities in the explanation of primary ovarian cancers which may assume the Krukenberg type. Pseudomucinous epithelium is frequently encountered, especially in the common pseudomucinous cystadenoma. The generally accepted view as to the origin of pseudomucinous cystadenomas is that they represent teratomas in which an entodermic type of epithelium swamps out other elements, just as in thyroid tumors of the ovary (*struma ovarii*) the thyroid tissue blots out other teratomatous elements. There would seem to be no reason why the mucoid entodermic epithelium might not be the starting point of malignant tumors of a mucocellular type. That this variety of epithelium is of teratomatous origin is further indicated by the not infrequent occurrence in ovarian teratomas of small, often microscopic, cysts lined by epithelium identical with that seen in pseudomucinous cystadenomas.

Other possible sources of this type of epithelium are in association with Brenner tumors of the ovary, as Meyer has shown, and in the so called Walthard cell nests or islets from which such tumors are believed to be derived, though numerically these are far less important possibilities than the one mentioned.

While there is not the slightest doubt, therefore, that in the vast majority of cases the Krukenberg tumor is a secondary one we believe that the evidence for a primary origin in a very small group of cases is very convincing.

In view of the commonly secondary character of Krukenberg tumor, as well as of other types of ovarian cancer, examination of the ovaries should never be omitted at operation for pyloric or other gastro intestinal cancers in women. The gynecologist, on the other hand, should explore the stomach and other abdominal viscera before proceeding with operations for ovarian cancer. Not infrequently unwise or useless operations will thus be avoided, although in a number of reported cases both the primary tumor and the pelvic organs have been removed. In some of these the patients have survived for a considerable number of years, x ray treatment having in some been used after operation (Neumann).

Our own material consists of 21 cases of Krukenberg tumor which have passed through our laboratory during the past 25 years, although this number includes 3 cases which have been previously reported by Hundley, and also the case previously reported by Dr C J Andrews, of Norfolk, already alluded to in this paper. Most of these cases have occurred in our own clinic, but a number have come from outside sources. For their kindness in permitting us to include these we are indebted to Doctors Karl H Martzloff, of Portland, Oregon, E L Bowlus of Frederick, Maryland, I C Youmans, of Miami, Florida, F S Johns, of Richmond, Virginia, Clyde Hawley, of New York, and L E Daniels, of Detroit, Michigan.

The ages of our patients varied from 22 to 60 years, with an average of 42. Three patients were colored, the remainder, white. In 18 cases the tumor was bilateral, in 3, unilateral. In 6 cases the primary growth was demonstrated by operation or autopsy to be in the stomach, and in 5 others in the large intestine. In most of the others a possible primary tumor was either not sought for or not found. Ascites was noted in only 4 patients (1500 to 3500 cubic centimeters), it is possible, however, that it may have been present in others.

In all but 5 cases we have been able to secure more or less complete follow up data. Thirteen patients are known to have died, all within relatively short periods after the operation (6 weeks to 14 months). In 3 other patients death was obviously imminent when the patients were last seen, all of these showing definite metastases, chiefly abdominal. In 4 patients no follow up data are available. Autopsies were done in 4 patients who died in the hospital, 3 of these showing more or less extensive metastases (1 to the retroperitoneal and celiac glands, 1 to the peritoneum, 1 to the omentum and liver). In the remaining case there were no demonstrable metastases, the patient dying from the primary growth, an annular carcinoma in the ileocecal region. In only 1 case that of the presumably primary Krukenberg tumor of Dr Andrews, has the patient remained well (4 years after the operation was performed).

SUMMARY

This paper is based upon the clinical and pathological study of 21 cases of Krukenberg tumor of the ovary. The gross and microscopic characteristics of this tumor are described, emphasis being put on the fact that only a minority of ovarian cancers secondary to gastro-intestinal carcinoma conform to the proper concept of the Krukenberg type. While other routes of dissemination, such as transperitoneal implantation, may explain the ovarian tumor in some cases, we believe that the lymphatic route is far more frequently concerned in this, as in other forms of secondary ovarian cancer and of cancer in general.

There can be no question that in the overwhelming majority of cases Krukenberg tumors are secondary, usually to some form of gastro-intestinal carcinoma, but we believe there is very strong evidence for a primary origin in the occasional case. In at least 2, and possibly 3, reported cases (including the case of Andrews, discussed in this paper), the tumors were quite typical, there was no evidence at operation of a primary lesion elsewhere, none developed after operation, and the patients were still in good health several years after operation. It is difficult to explain such cases except on the assumption of a primary origin in the ovary.

The prognosis in the common secondary Krukenberg tumor is practically hopeless, as is indicated by the follow-up of our own cases. This is what one would expect in cancer which has already reached the stage of

lymphatic dissemination necessary for transport of cells from the stomach, intestine, or gall bladder to the ovaries, assuming that this is the usual method of spread.

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A STUDY OF APPENDICITIS

An Analysis of 1,463 Consecutive Cases

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THE high mortality of appendicitis continues to be one of the most serious problems before the profession today. Reference to statistics for the United States, the State of New Jersey, and the City of Newark, as shown in Table I, reveals a startlingly high mortality and the ratio of deaths per 100,000 population runs surprisingly close in these three geographical areas. It may also be noted that the death rate has not materially lowered in the years quoted.

This study is a record of a series of cases which have been managed by a uniform plan of procedure with minor variations. Presentation of such a series offers an opportunity for helpful analysis and criticism. It is also prepared for comparison. Such comparative studies will eventually evolve a fundamental solution to the problem of appendicitis.

This statistical survey includes all cases of appendicitis admitted to the C-2 Surgical Division of the Newark City Hospital during a 10-year period from 1927 to 1936, inclusive. There are 6 similar surgical divisions in this hospital. The hospital is a municipal institution for the care of the indigent sick. There are no private departments. The majority of the cases come from the low economic levels of society. Usually this group is slow in seeking medical advice and often tries self-medication first. This fact is one of the main reasons for the late admission of the patient to the hospital. All too often the disease has progressed far beyond the safety limit.

All cases in this series came to operation. As soon as the diagnosis of appendicitis was made, operation was advised. If the disease was acute, operation was performed immediately.

If the disease was not acute, the operation was performed on the next elective operating day. In case of doubt, in which an accurate diagnosis of appendicitis could not be made but in which there was presumptive evidence of acute appendicitis, operation was also done as an emergency. We believe that the error of operating in a case of doubtful diagnosis in which we find the appendix blameless is far less serious than failure to operate upon a patient later proved by necropsy or late operation to have had appendicitis.

TABLE I—STATISTICAL DATA

Location	Year	Population	Total no. deaths	Deaths from appendicitis	Ratio per 100,000 population	Ratio to total deaths
United States	1929	216,317,515	1,383,363	17,687	15.2	1.27
	1930	218,560,800	1,341,350	18,100	15.3	1.34
	1931	220,421,000	1,321,557	18,133	15.8	1.36
	1932	220,122,200	1,308,520	17,711	14.9	1.3
	1933	225,770,000	1,347,106	17,717	14.7	1.32
	1934	226,626,000	1,306,903	18,129	14.3	1.29
	1935	227,521,000	1,307,752	16,142	12.7	1.16
	1936	227,979,546	1,307,752	602	15.1	1.31
New Jersey	1929	4,957,000	43,190	601	14.5	1.39
	1930	4,911,000	44,135	600	14.5	1.36
	1931	4,955,000	43,816	532	12.7	1.28
	1932	4,996,000	43,380	535	12.7	1.23
	1933	4,947,000	43,547	511	12.0	1.21
	1934	4,988,000	43,67	481	11.9	1.17
	1935	4,900,000	5,857	92	10.7	1.17
	1936	4,970,000	5,447	100	10.6	1.13
Newark N. J.	1927	415,000	5,306	92	20.6	1.73
	1928	410,000	4,850	91	21.1	1.93
	1929	415,000	5,125	88	20.5	1.71
	1930	416,000	4,901	90	20.8	1.79
	1931	415,000	4,906	48	12.7	1.16

From the C-2 Surgical Division of the Newark City Hospital

Many of these operations have been done by the attending surgeons. On the other hand, virtually all the cases in which no complications were found were operated upon by the house surgeon on the service with the assistance or supervision of an attending surgeon. In the event of complications, the operation was completed by the attending surgeon. During this 10-year period more than 25 different house officers, in addition to the attending staff, have participated in this series.

TECHNIQUE

A definite plan of technique has been followed. Therefore, the results do not represent the work of an individual, but they do represent the success or failure of a definitely planned routine uniformly carried out with minor variations.

In the acute cases which are severely dehydrated saline and glucose solution is used intravenously before operation. Neither morphine nor atropine is given before operation in the serious cases. In the elective group small doses of one of the barbiturates are used.

The McBurney incision was used in all cases in which the diagnosis was reasonably certain. In doubtful cases, the right rectus or midline incision was made. In a few instances, more than one incision was necessary.

In the typical case, the appendix is delivered, the meso-appendix is clamped, cut, and ligated with catgut. The wound edges are protected with rubber dam and gauze sponges. The appendix base is crushed with a strong clamp and a catgut ligature is applied in the groove left by the clamp. A purse-string inverting suture is placed, the appendix is severed with the cautery, the stump is inverted and the pursestring tied. A row of Czerny-Lembert sutures covers this inverted area and includes the meso-appendix stump so that all raw surfaces and edges are buried. If the appendix cannot be delivered into the wound, or if we are dealing with a condition which no longer is confined to the appendix, long strips of gauze or sponges are used to protect the healthy peritoneum from the operative field. The appendix is removed in all cases, unless the disease has so fixed the tissues that attempts at removal seem too dangerous.

The appendix was not removed in 3 cases of this series which were complicated by general peritonitis because removal would necessitate excessive trauma. Usually we are able to invert the stump. In a few instances, we can only ligate and cauterize the stump, because the induration and friability of the tissues make it impossible or inadvisable to attempt inversion. Suction is used to remove the purulent material from the abdominal cavity and special attention is given to the pelvis. If there has been a perforation, or if gangrene or an abscess is present, a Penrose drain is placed in the pelvis and another in the right coloparietal space. The drains are brought out, as a rule, through a stab wound. The wound is now closed in layers. In a McBurney incision, when we have not encountered suppuration or gangrene, catgut closure is used throughout. If suppuration or gangrene is encountered, tension sutures of silkworm gut including the fascia together with catgut layer closure are used and small strips of rubber dam are placed down to the fascia or to the peritoneum. Tension sutures of silkworm gut, which include the fascia, are used in all other types of incisions.

If a history of a chill is obtained and examination has eliminated other causes, the possibility of thrombophlebitis is suspected and a high ligation of the meso-appendix is performed in an effort to prevent the development of an ascending pylephlebitis. If there is a history of one or more chills, or, in the late cases, if the patient has a fever of the remittent (spiking) type, the ileocolic vein should be ligated.

The question of the so called expectant treatment of the late fulminating cases has been considered. In our opinion peritonitis of a variable degree is present in all fulminating cases, and we feel unable to judge which of these cases may localize safely and which of them may become a spreading peritonitis. Furthermore, we believe that in these cases the prompt removal of the offending appendix with as little trauma as possible, followed by adequate drainage when indicated, gives the patient the best chance for recovery. In the late cases when a definite abscess has formed every attempt is made to drain the abscess.

TABLE II—CASES AND MORTALITY BY YEARS

Year	No cases	No deaths	Mortality per cent
1927	154	3	1.95
1928	112	7	6.30
1929	167	1	0.60
1930	130	4	3.00
1931	184	7	3.80
1932	154	3	1.90
1933	136	5	3.70
1934	131	4	3.06
1935	146	3	2.37
1936	124	4	3.22
Total	1463	40	2.73

cavity without contaminating the general peritoneal cavity. In other words, the surgeon should not convert a well localized abscess into a general infection of the peritoneum. In these cases adequate drainage can usually be obtained by placing the incision over the abscess and approaching the abscess cavity without entering the general peritoneal cavity. However, some of the cases with a definitely localized abscess cannot be managed in this manner. In such cases the abdomen is opened through a McBurney incision, and if free pus is not encountered and if a definite abscess is located, a second incision is made lateral or posterior to the abscess mass. Drainage is then secured by introducing a curved clamp through the second incision into the abscess cavity under the guidance of the hand in the peritoneal cavity. In this manner the peritoneum is not infected. When the abscess is inaccessible by this technique, it may be necessary to use iodoform gauze to wall off a passageway to the abscess through which the abscess may be subsequently opened without contamination of the peritoneal cavity.

Anesthesia. Open drop ether was always used for children and colored patients. Local and spinal anesthesia were used in a few cases in which their use was definitely indicated. Nitrous oxide-oxygen-ether was administered to all other patients.

Postoperative management. As soon as the patient regains consciousness, water is given freely by mouth. Small doses of morphine or pantopon are given for pain as needed. The

TABLE III—CLASSIFICATION OF CASES

Type	Cases	Deaths	Mortality percentage
Ruptured	123	31	25.4
Gangrenous	120	4	3.3
Suppurative	169	3	1.8
Acute subacute chronic	1043	2	.19
Total	1463	40	2.73

indwelling Levin tube is used for vomiting after the first day. Gastric dilatation and intestinal distention are controlled by duodenal suction drainage through the Levin tube and by use of low glycerine enemas. With gastric dilatation the patient is also turned over on the abdomen, and the foot of the bed is elevated. Intravenous solution of 5 or 10 per cent glucose and normal saline are started at once on all serious cases and are continued until fluids are retained by mouth. If edema is noticed, salt is omitted in the intravenous solution. Transfusions are used when indicated as part of supportive treatment. In all cases in which intra abdominal drains are used, dependent drainage is favored by placing the patient in the right Sims' position. The bed remains flat. This position is maintained for 24 to 48 hours and is considered to be an important factor in the postoperative treatment. Removal of the intra abdominal drains is begun on the eighth or ninth day.

NUMBER OF CASES AND MORTALITY

During the 10 year period there were 1,463 cases of appendicitis with 40 deaths. The total mortality was 2.73 per cent. The mortality has varied from year to year as shown in Table II. We believe that this variation depends largely on the severity of the cases encountered during any given year.

CLASSIFICATION

We realize that clinical classification of appendicitis is difficult. Our grouping is a working classification and represents different stages in a disease process. This process may pass rapidly from the stage of an inflammation confined to the appendix to a spreading generalized peritonitis. Sufficient defensive reaction may hold the process to a limited area

TABLE IV.—INCIDENCE OF THE STAGES OF INFLAMMATION IN RELATION TO SEX AND RACE

	Male	Female	White	Colored
Ruptured	79	43	108	14
Gangrenous	93	36	118	11
Suppurative	108	61	154	15
Total	280	140	380	40
Acute, subacute, chronic	444	599	962	81
Total	724	739	1342	121

within the protective walls made up of several inflamed tissues in the neighborhood, so that the infection becomes localized. Simple mechanics, such as dilatations or strictures of the lumen, also play a large part in the pathogenesis of appendicitis. Concretions are usually the localizing point of gangrene or perforation and a fecalith near the base often causes the so called obstructive type which becomes rapidly gangrenous throughout. Thus the structural deformities and the pathological changes of the appendix, the resistance of the individual, and the virulence of the infection are important factors in the rate of progress in the disease process. The same conditions may be found after a few hours illness in some cases that are found after days of illness in others.

Our classification as shown in Table III, while arbitrary, serves to arrange the cases into groups which have similar pathology. It also has a distinct meaning from the viewpoint of morbidity and mortality. This is a clinical classification and is made at the time of operation by the attending surgeon.

The four groups may be described as follows:

1. The ruptured group. The appendix is grossly ruptured and there is local or general peritonitis. A gross abscess may also be present.

2. The gangrenous group. The appendix is microscopically gangrenous with local or general peritonitis.

3. The suppurative group. The appendix is neither ruptured nor gangrenous but presents all degrees of suppuration with local or general peritonitis.

TABLE V.—STAGES OF INFLAMMATION IN RELATION TO DECADES

Decades	Groups 1, 2, 3				Group 4			
	Male		Female		Male		Female	
	W	C	W	C	W	C	W	C
1-10	39	3	21	2	34	14	30	7
10-20	81	8	59	0	137	20	305	16
20-30	66	9	18	1	125	10	130	8
30-40	37	6	13	0	63	2	50	1
40-50	18	0	6	0	28	1	21	1
50-60	8	0	6	2	6	1	5	0
60-70	5	0	2	0	2	0	1	0
70-80	0	0	1	0	1	0	0	0
Total	254	26	126	14	396	48	566	33
Total	280		140		444		599	

4. The acute, subacute, and chronic group. This group includes all cases not in the three previous groups. Many of the acute cases presented marked evidence of acute inflammation but were included in this group when the process was confined to the appendix with no local peritonitis. The subacute and chronic cases presented milder types of inflammation and often revealed disturbances such as concretions, dilatations, strictures, and hypertrophy.

Frequently the surgeon will be uncertain in which group to place a given case. To avoid this difficulty, group 4 includes all but the fulminating cases.

A study of Table IV reveals that the incidence in the cases included in groups 1, 2, and 3 in the male exceeds that in the female by a ratio of approximately 2 to 1, while the incidence in the less active cases included in group 4 predominates in the female.

Tables VI, VII, and VIII, amplify important data contained in Tables IV and V.

In Table VI it will be noted that in the decade 1 to 10 years, there is lower incidence but higher mortality. The disease is rapidly progressive. In the decades 10 to 40 years, there is an increased rate of incidence with proportionately lowered mortality. In the age group 40 and over, there is lowered incidence with a raised mortality. Underlying degenerative, metabolic, and cardiovascular condi-

TABLE II—CASES AND MORTALITY BY YEARS

Year	No cases	No deaths	Mortality percentage
1927	154	3	1.95
1928	111	7	6.30
1929	167	1	0.60
1930	130	4	3.00
1931	134	7	5.20
1932	151	3	1.99
1933	156	5	3.20
1934	131	4	3.06
1935	146	2	1.37
1936	124	4	3.23
Total	1463	40	2.73

TABLE III—CLASSIFICATION OF CASES

Type	Cases	Deaths	Mortality percentage
Ruptured	122	31	25.4
Gangrenous	120	4	3.3
Suppurative	160	3	1.8
Acute subacute chronic	1043	2	.19
Total	1463	40	2.73

cavity without contaminating the general peritoneal cavity. In other words, the surgeon should not convert a well localized abscess into a general infection of the peritoneum. In these cases adequate drainage can usually be obtained by placing the incision over the abscess and approaching the abscess cavity without entering the general peritoneal cavity. However, some of the cases with a definitely localized abscess cannot be managed in this manner. In such cases the abdomen is opened through a McBurney incision, and if free pus is not encountered and if a definite abscess is located, a second incision is made lateral or posterior to the abscess mass. Drainage is then secured by introducing a curved clamp through the second incision into the abscess cavity under the guidance of the hand in the peritoneal cavity. In this manner the peritoneum is not infected. When the abscess is inaccessible by this technique, it may be necessary to use iodoform gauze to wall off a passageway to the abscess through which the abscess may be subsequently opened without contamination of the peritoneal cavity.

Anesthesia. Open drop ether was always used for children and colored patients. Local and spinal anesthesia were used in a few cases in which their use was definitely indicated. Nitrous oxide-oxygen ether was administered to all other patients.

Postoperative management. As soon as the patient regains consciousness, water is given freely by mouth. Small doses of morphine or pantopon are given for pain as needed. The

indwelling Levin tube is used for vomiting after the first day. Gastric dilatation and intestinal distention are controlled by duodenal suction drainage through the Levin tube and by use of low glycerine enemas. With gastric dilatation the patient is also turned over on the abdomen, and the foot of the bed is elevated. Intravenous solution of 5 or 10 per cent glucose and normal saline are started at once on all serious cases and are continued until fluids are retained by mouth. If edema is noticed, salt is omitted in the intravenous solution. Transfusions are used when indicated as part of supportive treatment. In all cases in which intra abdominal drains are used, dependent drainage is favored by placing the patient in the right Sims' position. The bed remains flat. This position is maintained for 24 to 48 hours and is considered to be an important factor in the postoperative treatment. Removal of the intra abdominal drains is begun on the eighth or ninth day.

NUMBER OF CASES AND MORTALITY

During the 10-year period there were 1,463 cases of appendicitis with 40 deaths. The total mortality was 2.73 per cent. The mortality has varied from year to year as shown in Table II. We believe that this variation depends largely on the severity of the cases encountered during any given year.

CLASSIFICATION

We realize that clinical classification of appendicitis is difficult. Our grouping is a working classification and represents different stages in a disease process. This process may pass rapidly from the stage of an inflammation confined to the appendix to a spreading generalized peritonitis. Sufficient defensive reaction may hold the process to a limited area

TABLE X—ANALYSIS OF DEATHS

Year	No RS	Age	Days Ill	Cath- ters	Incision	Operative findings	Complicating factors	Cause of death	Days PO
1927	†1 W M	24	3	o	RR	R G app Abs pent		Gen peritonitis	14
1927	2 C F	10	2	o	RR	R G app Abs pent	Rheumatic fever	Gen peritonitis	6
1927	3 W F	50	1	o	McB	Chr app	Pneumonia urine retention	Pneumonia	12
1928	4 W F	60	1	o	RR	S app	Myocarditis	Cerebral embolism	1
1928	5 W F	41	1	o	RR	R G app Abs		Gen peritonitis	9
1928	6 W M	40	7	o	RR	G app	Septicemia Pneumonia	Septicemia Pneumonia	24
1928	7 W F	40	2	o	McB	R G app Pent		Gen peritonitis	5
1928	8 W F	3	3	1	RR	R G app Pent		Gen peritonitis	3
1928	*9 W M	10	6	1	RR	R G app		Gen peritonitis	1
1928	10 W M	48	7	1	McB	R G app Abs		Gen peritonitis	7
1929	11 W M	5	2	o	RR	R G app Pent		Gen peritonitis	2
1929	†12 W F	10	5	o	M	R G app Pent		Gen peritonitis	11
1930	13 W F	5	2	o	McB	R G app Abs		Gen peritonitis	1
1930	14 W M	36	1	o	McB	R G app Pent Thrombosis of meso-appendix		Pylephlebitis Pneumonia	29
1930	*15 W M	5	1	o	McB	R G app	Pneumonia	Gen peritonitis	8
1931	16 W M	39	7	o	McB & RR	R G app Pent		Gen peritonitis	5
1931	†17 W F	56	1	o	RR	S app		Gen peritonitis	6
1931	18 W M	46	7	o	McB	Chr app	Pneumonia	Pneumonia	5
1931	19 W F	15	1	o	McB	G app Pent		Gen peritonitis	5
1931	20 W M	10	1	o	McB	R G App Pent.		Subphr Gen peritonitis	25
1931	21 C M	21	1	o	RR	G app Pent		Gen peritonitis	2
1931	22 W M	31	1	o	McB & RR	R G app Pent		Gen peritonitis	4
1932	23 C M	21	14	o	McB	R G app Pent		Gen peritonitis	10
1932	24 W M	12	2	o	RR	R G app Pent		Subphr Empyema	17
1932	25 W M	43	2	o	RR	R G app Abs	Pneumonia and empyema	Pneumonia, empyema	38
1933	26 W F	7	2	o	McB	R G app Pent		Gen peritonitis	1
1933	27 W M	4	5	o	RR	R G app Pent		Gen peritonitis	1
1933	28 W F	54	7	o	McB	G app	Obesity Diabetes mellitus	Diabetic Coma Gen peritonitis	2
1933	*29 C F	55	3	o	McB	R G app Abs Pent		Gen peritonitis	1
1933	30 W F	59	1	o	RR	R G app Pent.		Gen peritonitis	3
1934	31 W F	28	1	1	McB	R G app Pent		Gen peritonitis	1
1934	32 W F	73	3	1	RR	R G app Pent		Gen peritonitis	3
1934	33 W M	17	4	o	RR	R G app Abs		Gen peritonitis	2
1934	34 W M	44	14	o	RR	R G app Abs	Fecal fistula subphr	Subphr Gen peritonitis	15
1935	35 C M	32	3	o	RR	R G app Pent Pylephlebitis		Pylephlebitis—L. abs	3
1935	36 W M	30	4	o	McB & R.R.	R G app Pent. Pylephlebitis		Pylephlebitis L. Abs subphr	42
1936	37 C F	52	1	o	McB	R G app Pent	Diabetes	Diabetes Gen peritonitis	13
1936	38 W M	19	3	o	McB	S app		Gen peritonitis	5
1936	39 W M	30	2	o	McB & RR	R G Pent		Gen peritonitis	6
1936	†40 W F	40	2	o	RR	R G app Pent Pylephlebitis		Gen peritonitis	8

*Appendix not removed
†Not drained
‡Enterostomy
§Ileocolic veins ligated

M—Male
F—Female
W—White
C—Colored

R—Ruptured
G—Gangrenous
S—Suppurative
McB—McBurney
R.R.—Right rectus
M—Midline

App—Appendix
Abs—Abscess
Subphr—Subphrenic abscess
L—Liver

TABLE VI—STATISTICS OF THE TOTAL INCIDENCE AND OF THE FATAL CASES ACCORDING TO AGE

Decade	Total cases	Incidence per cent	Deaths	Percentage	Mortality per cent
1-10	156	10.7	6	5	3.8
10-20	637		8		
20-30	376	81.5	4	45	1.5
30-40	179		0		
40-50	74		8		
50-60	8	2.8	0	40	11.9
60-70	10		2		
70-80	4		0		
Total	413	100	40		2.23

TABLE VII—STATISTICS OF THE TOTAL INCIDENCE AND OF THE FATAL CASES ACCORDING TO RACE

Race	Total cases	Fatal cases	Mortality per cent
White	1345	34	2.5
Colored	21	6	4.9
Total	1463	40	2.71

TABLE VIII—STATISTICS OF THE TOTAL INCIDENCE AND OF THE FATAL CASES ACCORDING TO SEX

Sex	Total cases	Fatal cases	Mortality per cent
Male	724	22	3.04
Female	730	18	2.43
Total	1453	40	2.71

tions play an important part in increasing the mortality in these decades.

About 70 per cent of appendicitis occurs between the tenth and thirtieth years. Over 80 per cent occurs between the tenth and fortieth years. The youngest in this series was 1 year and the oldest 78 years.

The race incidence ratio as shown in Table VII is white to colored 11 to 1. The population of Newark, New Jersey is white, 415,000, colored 42,000, which is a ratio of 9.08 to 1. The disease incidence is definitely lower for the colored population while the mortality ratio is much higher.

The sex ratio of incidence as shown in Table VIII, male to female is as 1 is to 1.02. The total mortality percentage is higher in the male. However, in the fulminating cases the mortality is higher in the female (12 per cent).

TABLE IX—SUMMARY OF THE CAUSES OF DEATH

	Total cases
A General peritonitis	
Complications—	
Subphrenic abscess	3
Ruptured appendix with abscess	3
Pelvic abscess	1
Rheumatic endocarditis	1
Diabetic acidosis	2
Lymphlethitis	1
B Pneumonia	
Complications—	
Empyema	1
Septicemia	1
C Pyklophlebitis	
D Cerebral embolism	
E Septicemia	
Complications—	
Bronchopneumonia	1
Total	40

Note: Pneumonia was the cause of the 2 deaths in the fourth group (acute, subacute and chronic).

than in the male (7.5 per cent). This computation is based on Table V and Table X.

HISTORY OF FATAL CASES

An accurate history of the onset of the disease was often difficult to obtain. Many of the patients were indefinite about the first symptoms. Of the 40 patients who died, 13 had been ill 1 day, 9, 2 days, 6, 3 days, 4 days, 1, 5 days, and 1, 6 days. Five patients had been ill over a period of 1 week, and 2 for 2 weeks. Two thirds or 25 cases were ill over 48 hours and one half of these were ill 4 days or longer. A cathartic had been taken before operation in only 5 cases. Our observation noted comparative safety if operation was performed within 18 hours after onset. After that time the danger rises in direct proportion to the time elapsing between the onset and operation.

In the 40 patients who died the McBurney incision was used in 17, right rectus in 18, right rectus and McBurney in 4, and midline in 1.

SUMMARY

1. A series of 1,463 consecutive cases of appendicitis is presented with a mortality of 2.73 per cent. All patients were operated upon.

2. The recording of a large series of cases following a uniform technique is of value.

THE RELATION OF CARTILAGE TO THE REPAIR OF BONE

J. DEWEY BISGARD, M.D., and J. MATTHEWS FARRIS, M.D., Omaha, Nebraska

SINCE much of the skeleton is chondral in origin and since much of the new bone in the repair of fractures and of defects from the loss of substance is laid down in preformed cartilage, there can be no question that under certain circumstances cartilage plays an essential and constructive rôle in ossification. In this rôle cartilage is embryonic in type.

As it matures to adult type, it becomes a somewhat fixed tissue and not only loses its osteogenic principle but becomes one of the least ossifiable of tissues and acts as a barrier to the repair of bone when it is interposed between fragments. Clinically, this is observed as a physiological principle, normally in the case of joints and pathologically in pseudoarthrosis.

These important differences between mature and immature cartilage are shown in the experimental observations which follow.

EXPERIMENTS

In 21 rabbits a segment of the shaft of each radius, approximately 20 millimeters long, was removed subperiosteally. In each animal the defect in the left radius was left empty and served as a control. Into the defects on the right side cartilage was transplanted and, according to the type of cartilage used, the experimental procedures diverge and fall into three groups.

Group I In 14 immature rabbits (1 to 3 months old) the radial defects on the right side were filled with autogenous transplants of costal cartilage. These grafts were sufficiently long to bridge the gaps between the fragments completely. Roentgenographical, gross, and microscopical examinations 12 weeks after operation showed: (1) union of fragments with partial or complete replacement of the resected segments in 12 of the 14 control defects (those left empty) and (2) the converse situation in the extremities in which the de-

fects were filled with costal cartilage. In this group not only was there failure of replacement of the resected segments but also failure of regeneration of sufficient bone to establish continuity between the fragments. In most instances there had been no replacement of bone whatever except at the ends of the fragments and very little or no evidence of osteogenic activity from the periosteum.

Histological examination showed that the cartilage had remained unchanged except where it contacted bone. Here, new bone arising from the fragments had fused with the cartilage by incrustation and superficial invasion.

Thus, the cartilage interposed between the fragments not only failed to ossify and to promote ossification but actually acted as a barrier to normal repair.

Incidental to the abnormal stress upon the ulna from the break in continuity of the radius there developed separation with displacement of the distal ulnar epiphysis in one-half of the extremities operated upon. In all of these, complete or nearly complete reduction took place spontaneously, but on the shaft of 7 of the ulnas there developed at the distal end where



Fig 1 Roentgenograms of both forefeet of rabbit 6, showing subperiosteal resection of a segment of the shaft of each radius. The defect in the left radius—at left—received no graft and served as a control. It became completely repaired. The defect in the right radius—at right—which was filled with an autogenous transplant of costal cartilage failed to repair. Note shadow of cartilaginous transplant.

From the Departments of Surgery and Physiology, University of Nebraska School of Medicine

Study of such a series will develop helpful leads whereby we may improve our management of appendicitis

3 The McBurney incision is our choice in acute appendicitis

4 The history of a chill in acute appendicitis, not explained by complicating disease, is significant of thrombophlebitis of the appendiceal vein. Under such circumstances high ligation of the meso appendix should be done and the ileocolic vein inspected and ligated if thrombosed

5 Dependent drainage is an important element in postoperative management of appendicitis

6 All procedures should be carried out with the idea of preventing peritoneal con-

tamination and spreading of local infection. Late cases with localized abscess should be drained without contamination of the general peritoneal cavity

7 The so called expectant treatment in late fulminating cases has not been practiced in this series

8 The medical profession must find ways and means better to inform the public of the great hazard of delaying operation

9 While we appreciate the fact that the human factors will make it impossible completely to prevent deaths in a large series of cases, nevertheless continued efforts to improve methods and an intensive education campaign for the laity will bring us surely, although slowly, toward that goal

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From the Departments of Surgery and Physiology, University of Nebraska School of Medicine



Fig 2



Fig 3

Fig 2 Repetition of result illustrated in Figure 1. The control defect in left leg—at left—became completely repaired—the right one (filled with costal cartilage) failed to repair—at right. Note slipped distal epiphysis of the left ulna and the formation of an osteochondroma.

Fig 3 The defect in the left radius (the control)—at left—received no graft and promptly filled with new bone

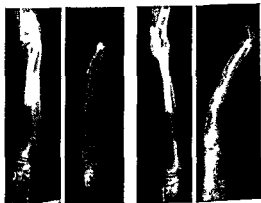


Fig 4

Into the defect of the right radius—at right—was placed fetal cartilage from the recipient's own fetus. Failure of repair resulted.

Fig 4 Bilateral radial defects. The left one—at left—was filled with an autogenous transplant of costal cartilage and failed to repair. The right one—at right—was bridged with an autogenous transplant of epiphyseal cartilage and became filled completely with new bone. It is to be noted that there is complete displacement and subsequent spontaneous replacement of the distal epiphysis of the left ulna.

separation occurred tumors composed of bone in 2 and of both cartilage and bone in 5, histologically osteomas and osteochondromas. In the distal fragment of the radius of 1 animal a giant cell tumor formed. A report of a study of these tumors was made in a previous publication.¹

Group II In this group 6 mature rabbits were used, and the defect in each right radius was filled with unossified but preosseous fetal cartilage and a defect on the opposite radius

used as a control. The fetuses from 2 to 3 weeks old were obtained by cesarean section in 2 instances and by induced premature labor in 1. The ribs, which at this stage of fetal life are almost entirely cartilaginous, were resected and divided into two equal parts, one portion being transplanted to the right radial defect of the maternal recipient and the other to a right radial defect in an unrelated animal. A comparison of the results 12 weeks after operation showed replacement of the resected segments of the radius by new bone in 4 of the 6 defects which received no transplants (the controls),

Burgard J D Experimental giant cell tumors and cartilaginous exostoses of bone. Arch Surg 1935 p 88



Fig 5 Serial roentgenograms of bilateral radial defects. Both repaired completely. The left one—3 at left—received no graft serving as a control, the right one—3 at right—was bridged with epiphyseal car-

tilage and absence of bone in all of those filled with fetal cartilage. The grafts in 2 of the 3 "fetus to mother transplantations" had been entirely absorbed, while those in the other group, the heterogeneous transplants, were undergoing absorption and were surrounded by granulation tissue and by round cells and foreign body giant cells and were encysted in fibrous tissue. New bone was present only at the resected ends of the fragments and at these sites in small amounts only.

Under the circumstances of this experiment, the osteogenic propensity of fetal cartilage cannot be judged. Its failure to give rise to new bone and its interference with normal repair are undoubtedly the result of tissue incompatibility, so often the fate of heterogeneous transplants. The transplants to unrelated animals not only were undergoing absorption but also had provoked considerable foreign body inflammatory reaction.

Group III In each of 4 young rabbits several small bits of cartilage¹ were removed from the epiphyseal cartilage plate of the distal end of the femur and were placed in the radial defects on the right side. In 3 animals the defect on the left side was left empty and in 1 it was

filled with autogenous costal cartilage. Within 1 week after operation all defects except the 4 containing costal cartilage had become filled with new bone. The defect containing costal cartilage had failed to repair. In all cases new bone had appeared earlier and definitely in larger quantities in the spaces to which epiphyseal cartilage had been transplanted, and sections through the newly formed bone revealed several small islands of cartilage, but whether this cartilage was that originally transplanted or was newly formed could not be determined. Slipping of the distal ulnar epiphyses occurred in 2 animals.

CONCLUSIONS

The results of these experiments confirm the clinical observations that, osteogenically, cartilage exists in two forms. In its embryonic form, characterized by the epiphyseal cartilage, it is very cellular and contains relatively little matrix and as such unquestionably plays an essential and constructive rôle in ossification. As a mature type of tissue with fewer cells and an abundance of matrix it not only loses its osteogenic propensity and becomes a somewhat fixed tissue and one of the least ossifiable but also acts as a barrier to repair of bone when interposed between fragments.

¹Since the epiphyseal cartilage plate is so small it is impossible to be sure that these tiny transplants were entirely free from minute spicules of bone.

AN INEXHAUSTIBLE SOURCE OF BLOOD FOR TRANSFUSION AND ITS PRESERVATION

Preliminary Report

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THE teaching that, if the blood is left in the placenta, placental detachment from the uterine wall is hastened, has never had any scientific appeal to us. Consequently, it became a problem to be proved or disproved. So, at every birth, on our service, the clamp on the cut cord was released with the cord in a pendent position and the placenta was emptied so that the cord lay flaccid instead of quite turgid as was previously the case. The separation of the placenta was not appreciably changed either in elapsed time or complete-ness. A very important new factor was disclosed however: the blood pressure in the cord was great projecting the blood frequently 3 feet distant and the flow kept up a surprisingly long time. The thought occurred to us, why waste all this valuable material? So means were at once established to preserve this lost blood.

The first thing to be considered was a preservative. After much experimentation, it was found that the preservative proposed by the Moscow Institute of Haematology was the best available. A simple means of collecting the blood without contamination was established, and finally, considerable study was given to determining the best atmosphere for conserving the blood in its freshness. Blood grouping and Wassermann reactions received due consideration. The result of our work has been to provide an inexhaustible source of blood for transfusion and to preserve the blood at a minimum of cost and in a condition suitable for a transfusion medium for at least 60 days.

Technique. When the baby is born it is laid upon the mother's abdomen. The cord

is tied or clamped and wiped clean with a sponge moistened in 75 per cent alcohol. The cord is stripped free of blood for about 6 inches, by the left finger and thumb armed with a sponge. The cord is cut with a sterile scissors the severed end lowered to below the vulva. A special towel with a 2 inch hole in its middle is put over the hand, holding the cord in such a manner that the hand is opposite the hole. The towel is clamped to the operator's gown near the elbow with an Allis forceps. The end of the cord is passed through the aperture in the towel, and so placed that its end hangs in the funnel of the receptacle held by the nurse. Pressure on the cord is then released completely and the blood is collected. Pressure on the fundus by the nurse or assistant hastens the emptying of the placenta. When completed, the cord is clamped and the collecting has been accomplished. The towel described is used to prevent any contamination of the cord and receptacle by any fluid extraneous to that under collection. The process occupies about 3 minutes, and the average amount collected from each patient may vary from 100 to 150 cubic centimeters with an average of about 125 cubic centimeters. The technique used in collecting the blood is extremely simple and blood is always available when it is needed for transfusion.

Preservative. The preservative that has been found to be most suitable that proposed by the Moscow Institute of Haematology, consists of the following ingredients and their dilutions:

Sodium chloride	7.0 gm
Sodium citrate	5.0 gm
Potassium chloride	0.2 gm
Magnesium sulphate	0.004 gm
R ₁ -distilled water	1000.0 c cm

From the wards and Research Laboratory of St Mary's Hospital

This solution¹ is now put up in ampuls of 25 cubic centimeters which, when added to 100 cubic centimeters of distilled water, gives one the proper dilution, so that preservative and blood from each case is mixed in equal proportions, 125 cubic centimeters of preservative and, roughly, 125 cubic centimeters of fetal blood.

Preparation of receptacle A wide based glass flask of 300 cubic centimeters capacity and a glass funnel are thoroughly cleansed and rinsed several times with distilled water. One hundred cubic centimeters of distilled water and the contents of an ampul are put in each flask and corked with a stopper of absorbent cotton in gauze tied at the top. The flask and funnel are wrapped separately in a cloth and sterilized in the autoclave. When cooled they are ready for use. When blood is to be collected, the funnel is partially released from its cover and is handed aseptically to the surgeon. The flask covering is released from the top, so that when the nurse holds the flask by the base the cloth falls over her hand. The surgeon places the funnel in the flask, and the nurse holds these in position for receiving the blood. When the blood has been collected in the flask, a few drops from the end of the cord are taken in test tubes, one for grouping, the other for the Wassermann, if the mother's blood has not already been tested for the reaction. As all prospective mothers in our service have had Wassermann reaction tests made during their pregnancies, duplication of this test is not necessary. The flask and tubes are labeled with the patient's name and the date and are transferred to a refrigerator with a temperature between 33 and 38 degrees Fahrenheit. Temporary changes of this temperature do not affect the character of the blood.

The blood is ready for transfusion as soon as the grouping and reaction are completed. Groups 2 and 3 are kept in the upper shelves of the refrigerator. Groups 1 and 4 on the lower shelves, so that at a glance one can estimate the quantities in stock.

A clock thermometer on the top of the refrigerator indicates the temperature so

that it is not necessary to open the door. Defrosting should be done once a month, without removing the blood.

Conditions. There are certain conditions which become axiomatic as regards mother, child, and accidents of labor. Blood of the placenta will, of course, not be taken in cases of obvious transmissible disease in either mother or child. Eclampsia is not a contra-indication, however. Blood will not be taken in cases in which the membranes have ruptured for more than 48 hours before delivery, nor in cases of definite prematurity. In cases of marked asphyxia pallida, the amount of blood in the placenta is so small as to make it worthless.

Observations. Babies at full term have a fixed blood group. Consequently, the groups of donors of placental blood are relatively numerically the same as in the recipients. The supply in each group therefore will approximate the demand for each group. Major reactions are all that are necessary in cross-matching. Cultures of the preserved blood are unnecessary because, at the low temperature for preservation, contamination, if present, could not propagate, and consequently would be so attenuated as to be innocuous. When the placental blood settles, it frequently differentiates itself into three layers. The lowest is composed of red blood cells, the next is a thick buffy coat, and the third the supernatant clear fluid. Slight progressive hemolysis and consequent coloring of the supernatant fluid may occur after the first 15 days. This, even major degrees of hemolysis, is no barrier to a normal transfusion. Stirring or unnecessary movement of the blood is productive of slight hemolysis. The reason for the innocuousness of this hemolysis lies in the fact, that it would seem that the hemolysin is in infinitesimally small quantity and is inoperative in the recipient. Moreover, it is believed that the hemolysis is the result of the preservative upon fetal nucleated red blood cells, of which normal fetal blood contains quite a few, which possess greater fragility than adult red cells. This subject is under further study. Fetal blood, as regards cellular content, contains quantitatively approximately 7,000,000 red blood cells to the 4,500,000 of the adult.

¹This preparation is prepared by Ayerst, McKenna & Harrison, Montreal, under the name "Citro-seroid."

Its cellular strength, therefore, is about 150 per cent of that of the adult. Less fetal blood is therefore required. Every normal child at birth has therefore a well marked polycythemia. The reason for that is readily explained. In interchange of oxygen and carbon dioxide in the lungs between air and blood is at its optimum and is the equivalent of 100 per cent physiological effect. In the placenta, on the contrary, the interchange is between the maternal and fetal blood, and maximum interchange cannot exceed 50 per cent. Consequently, the fetal blood must have many more carriers, each with a degree of anoxemia, to extract a larger quota from the maternal fluids. This is self evident. If the fetus did not have this high degree of polycythemia, the fetus would be in a constant state of anoxemia. After birth, when the lungs come into operation, the excess of red blood cells becomes unnecessary, and the breaking down of these is the cause of many of the cases of hemolytic jaundice in the newborn. This explanation is advanced to meet the argument that in taking the blood from the placenta, one is depriving the newborn of its rightful due, and that one should wait until the contractions of the uterus have squeezed some of the placental blood into the fetal circulation.

Fetal blood contains from 20 to 35 per cent more coagulation power than that of adult blood. This, it is thought, is nature's provision to prevent exsanguination of the newborn in animals in which the cord is torn or bitten. This increase is gradually lost in the 10 days following birth. From the point of view of transfusion, this is an advantage in hemorrhagic cases, and it does not appear a contra indication of septic thrombophlebitis.

Preserved blood has many advantages over fresh blood. In the first place, food and other extraneous allergic reactions are eliminated. It is now a standing rule that, when possible, donors should not be used for some hours after ingestion of food. This is to obviate food allergic reactions. It is well known that certain individuals absorb a large quantity of

unsplit proteins during digestion and that these are capable of being neutralized by the allergins of that specific person, but the recipient may not be so fortunate, and, if not, an allergic reaction must follow. In preserved blood, autodigestion occurs and allergic reactions do not occur after 48 hours of preservation. A very amusing incident will accentuate this anomaly. A patient of ours was under transfusion from a donor. She suddenly developed hives. The transfusion was stopped and after the injection of adrenalin, the transfusion was resumed. When questioned upon her reactions to food, she stated that the only ingredient that she knew she could not take was gin. It always produced hives and she had not touched it for 15 years. When the donor was asked how much gin he had had that morning, in great alarm he answered, "I swear to heaven that I had only one drink, sir." He is still guessing how we knew.

In the many transfusions with fetal blood there has not been one untoward reaction, nor a single rise of temperature, even to a fraction of a degree, attributable to the transfusion. Before transfusion, the fetal blood should be heated in a basin of water and shaken before transmission. It should be filtered through two layers of sterile gauze. Two or more fetal bloods may be given simultaneously, if necessary, after separate matching.

A maternity section of a general hospital proportionate in size will give more than enough blood for the needs of the whole institution. Blood can be sent to other institutions in adequate thermos containers, if the group of the recipient is known.

The cost of installation varies with the custom duties of the different countries. In Canada, installation costs approximately 200 dollars. It would be much less in the United States. The installation soon becomes a source of revenue in that the charge to the private patients may be that of the usual donor's fee.

It is a safe, constant, efficient, and lucrative source of blood for transfusion.

OBSTETRIC ANESTHESIA

I. A Laboratory Method for Studying the Effects of Anesthetic and Analgesic Agents on Both the Uterus and Fetus

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PUBLIC demand for relief of pain during childbirth has been responsible for a feverish search for a safe and effective obstetric anesthetic. Critical analysis of the voluminous and somewhat contradictory literature of the past 35 years reveals that an ideal anesthetic has not been found and that progress in this field has not been as great as might be hoped from the efforts extended. The question is raised also whether or not the use of obstetrical anesthesia may not play a part in maintaining the excessively high maternal and neonatal mortality rates during an era when other mortality rates have made a significant decline.

It is nearly impossible to obtain authentic information regarding the safety of the different anesthetics and analgesics in use because of unreliability of research methods and the interpretations made from them. Some of the faults in the methods of collecting and interpreting data are: lack of uniformity in the clinical standards used to judge the effects of drugs upon mother and child; use of an insufficient number of experimental subjects and controls; attempting to evaluate the effects of a drug while it is being used in combination with several, and insufficient use of precise laboratory methods. The outstanding need is for development of laboratory procedures which can be used preliminarily upon experimental animals before studies are made upon humans. Such methods may be used to confirm or refute some of the incomplete evidence which indicates that uterine contractions may be decreased and fetal asphyxia increased by these drugs. It is with this hope in mind that some of the methods that have

been used will be discussed and our experience with a recently developed laboratory method will be related.

METHODS OF PRECISION IN USE

Several methods of precision have been devised to determine the reaction of the uterine musculature to various anesthetics and analgesics. Unfortunately, studies of this nature have been too few to make it possible to arrive at convincing conclusions about these preparations. In fact, some of the methods have not been tried sufficiently entirely to satisfy some of the objections raised about them.

Excised uterine muscle test. By this laboratory procedure the effect of the various compounds on the uterus is determined by infusing a piece of excised uterine muscle with a solution of the test substance. The muscle is connected to a stylus which records the uterine contractions upon a revolving drum. While there are many objections to the use of this *in vitro* method, considerable information, at least of a preliminary nature, may be obtained before humans are subjected to the drug under consideration.

Internal hysterographic method. There is no need to describe at length the various procedures that have been devised to register graphically uterine contractions in parturients, for recently Dodek has done this in splendid fashion. Suffice it to say that internal hysterography was tried as early as 1872. Essentially the method is based upon the use of a rubber bag which is inserted under aseptic precautions either into the parturient human cervix or into the uterine cavity past the presenting fetal part. The amniotic sac should not be ruptured. The bag is attached to a rubber tube, and, after the two are filled with fluid, they are connected to a delicate tambour

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or mercury manometer provided with a stylus which marks the uterine pressure variations upon a revolving recording drum. Recent studies based on this method have been made by Bourne and Burn, by Rucker, and by Kane and Roth in an endeavor to ascertain the effect of anesthetics and analgesics upon uterine contractions. So far an insufficient number of studies have been reported to arrive at very definite conclusions. Further more, internal hysterography has been criticized for several reasons. It subjects the patient to the dangers of intra uterine manipulation. Introduction of a bag may cause an abnormal response by the uterus thus providing a complicating factor in evaluating the effect of an anesthetic or analgesic upon uterine contractions. Finally, the method is sufficiently complicated to limit its generalized use by clinical investigators. Nevertheless, a great deal of valuable information might be obtained if the method were used more extensively.

External hysterographic method. As early as 1920 Rubsamen employed a method of recording uterine contractions from without the birth canal by registering changes of position of the abdominal wall. Mahon in 1930 reported using an external hysterographic method. In 1932 Dodek devised a simple method which was based on the fact that with each contraction of the uterus the antero-posterior diameter of the abdomen is increased in direct proportion to the intensity of the contraction. He fixed a plunger and diaphragm of a closed air system to the abdomen in the region of the umbilicus so that each contraction compressed the air which raised a stylus attached to a sensitive rubber tambour. The stylus recorded the contractions upon a revolving recording drum. The apparatus was fixed to the abdomen by tape. While the instrument is sensitive to uterine contractions it is relatively insensitive to ordinary abdominal movements of a minor character. For this reason as well as avoidance of hazards to the patient from intra uterine manipulations, the method should be a valuable adjunct to the study of uterine contractions under anesthesia or analgesia. Further more, observations can be carried out for

longer periods of time. So far few investigators have used external hysterography.

There is need for a laboratory procedure which may be used to determine the effects of the different anesthetics and analgesics upon the animal uterus before they are tried on humans. In the past year Rosenfeld and Snyder described a method that should be of a great deal of value in this respect. It has been used by them to ascertain the effect of anesthetics or analgesics upon the fetus *in utero* but we have found it useful in making observations of the effects of these substances on the uterine contractions as well. The method is described below.

METHOD OF ROSENFELD AND SNYDER

The abdominal and perineal regions of rabbits were anesthetized by transecting the lumbar spinal cord under local anesthesia. The animal was then partially immersed in a bath of Ringer's solution of body temperature. The abdominal wall was incised and the uterus was exposed. Various volatile anesthetics were administered through a cannula which had been inserted into the trachea of the mother, under local anesthesia. Solid analgesics were also administered in the usual way. The action of the different compounds upon the fetal respiratory movements were noted with the naked eye. Later motion picture studies were made with the assistance of Eastman (4).

We have employed this method with a few modifications. In some instances the cord was transected under ether anesthesia, but when this was done a day or two was permitted to elapse before the abdomen was opened, so that the effects of the anesthesia had worn off. By cutting the cord at a higher level the fifth and sixth thoracic vertebrae, the upper abdomen was anesthetized and the animal was not as restless. Most of the observations were made through the exposed but intact uterus. However in some cases the uterus was opened in order to study more closely the fetal respiratory movements through the transparent fetal membranes. In a few instances the outer chorionic layer was opened to eliminate some of the reflected light which at times prevented the enclosed

fetus from being clearly visible. Instead of using ordinary black and white film we have made our pictures with color film (kodachrome). Artificial illumination was furnished by four 750 watt photoflood mazda lamps so arranged that they could be adjusted in suitable positions. The camera was fixed in a frame at 2 feet from the object, and after the preliminary adjustments were made this stand could be brought into position quickly without requiring repeated focusing. This made it possible to standardize and simplify the photographic technique. The most satisfactory exposures were obtained with an aperture of F 2.8 using a 16 millimeter Eastman ciné-kodak with a F.19 lens and a speed of 16 frames per second. This photographic procedure made it possible to record movements that sometimes were overlooked when making direct observations and at the same time permitted permanent records to be made which could be reviewed from time to time. The use of color film made it easier to differentiate the various structures so that more accurate observation of details was possible.

FETAL RESPIRATORY MOVEMENTS

While mention has been made from time to time of respiratory-like movements in fetuses so little attention has been paid them that their existence still remains a doubtful matter to many. Thus, in the 1936 edition of *Williams' Obstetrics* Stander states that the conclusions of Ahlfeld regarding fetal respiratory movements have not been generally accepted and "we are still in doubt as to the significance of his observations." Preyer, in 1885 mentioned that Vesalius had observed such movements when the fetal circulation had been interrupted and that Winslow in 1787 observed rhythmic dilatation and contraction of the nasal orifices, expansion and contraction of the thoracic wall, and movement of the abdominal wall in the fetuses in the amniotic sac following exposure of the uterus. Beclard made similar observations in 1815. In spite of occasional references of this sort no particular notice was taken of the subject until Ahlfeld in 1905 reviewed two previous reports of his own and published graphic

records of rhythmic pulsations of the abdominal wall of pregnant women which seemed unrelated to maternal respirations or pulse. His views met with considerable opposition. In 1911 Reifferscheid confirmed these observations with graphic records and concluded movements of the fetal thorax resembling the respiratory act occurred *in utero* and that they were physiologic. In 1933 Klemperer failed to observe these movements consistently in anesthetized animals in which the uterus was exposed. Probably the reason for this is that anesthesia interferes with movements.

In 1935, Rosenfeld and Snyder noticed spontaneous fetal respiratory movements in the intact, but exposed, uterus of rabbits whose spinal cords had been transected. These were characterized by rhythmic excursions of the thorax and abdomen which, while shallower, resembled qualitatively the respiratory act in the newborn. Fetuses within the same uterine horn showed great variation in respiratory activity, some being quiescent while others exhibited these movements at varying rates up to sixty per minute. They thought that the movements were not initiated by the experimental procedure because they could be seen after careful observation of the unopened abdominal wall of unoperated upon pregnant animals.

By the use of ether, paraldehyde, sodium phenobarbital, and sodium-pentobarbital in amounts that did not impair the maternal respiration but caused light anesthesia, they found that the intra-uterine respiratory movements were either seriously depressed or inhibited completely. Eastman (5) who has been intensely interested in the work of Rosenfeld and Snyder mentions that they have also demonstrated these rhythmic intra-uterine movements in the cat, guinea pig, and monkey. After carefully reviewing the scanty literature on the subject and after making personal observations which will be related below, we have come to the conclusions that intra-uterine respiratory movements of the fetus occur, that they are physiologic, and that they are not initiated by asphyxial changes in the fetal blood nor by stimulation as a result of handling.

AUTHORS' OBSERVATIONS

Using the method described herein, observations were made on 10 rabbits, 5 dogs, and 7 rats, and color motion pictures were taken. The following observations were made.

1 *Fetal respiratory movements* Through the intact uterus periodic rhythmic excursions of the fetal thorax and abdomen were observed. There seemed to be no synchronous action between the different fetuses, some remaining quiescent while others were active. These movements seemed to be of about equal intensity or amplitude but not of the same rate. Frequently all were inactive for a short time. One rabbit (No. 7) was observed for over $1\frac{1}{2}$ hours and during this time, save for a period of 2 minutes, one of the fetuses continued to manifest these rhythmic movements uninterruptedly. Sometimes as many as 3 fetuses showed respiratory activity. These movements were affected by several factors. In premature fetuses the respiratory activity was not as great as in full term animals. The movements often stopped when the fetus kicked and squirmed about. During intense uterine contractions the respiratory movements ceased or were at least considerably reduced or obscured. Frequently the rate was increased after the uterine contraction had subsided. The thoracic abdominal movements did not seem to be disturbed when the uterus was opened and the amniotic sac exposed unless, as happened several times, the placenta became detached. Viewed through the transparent fetal membranes the movements simulated very closely the respiratory act in newly born animals. First, the chest was raised upward and outward suddenly while the abdomen retracted. Then the chest retracted and the abdomen expanded, but this movement was not as rapid as the initial one. During this act the ribs moved upward and downward. The respiratory like movements, in dogs especially, were accompanied in most instances by alternate opening and closing of the mouth. In rat fetuses this was not as noticeable. We observed two distinct types of movements. The first was a rhythmic and regular act of relatively uniform amplitude unaccompanied by any other fetal

activity. The second resembled an asphyxial gasp in which the mouth was opened wide if the excursion was violent. Movements of this sort usually were not rhythmic, and preceded or occasionally were accompanied by active limb movements. The fetus appeared to be struggling for breath. In rats greater variation of rate and rhythm was seen. At times the movements were so rapid that the chest did not have time to relax completely between excursions. This was followed by a pause simulating closely the apnea following a series of rapid respirations in delivered animals. When the umbilical cord was clamped, increased fetal and respiratory activity was usually, but not always observed. With rat fetuses this was not as likely to happen. The width the mouth was opened depended upon the intensity of the thoracic excursion.

The respiratory movements were stopped within 5 minutes by light ether anesthesia at which time the usual fetal response to tactile stimulation was absent. At the beginning of the anesthesia the rate was often increased. Within 5 to 10 minutes after withdrawal of the anesthetic, occasional excursions of the thorax were seen and by 15 to 20 minutes they had become regular again but the rate was slower.

Sodium iso amyl ethyl barbiturate (sodium amtal) in doses sufficient to produce analgesia and drowsiness was found to affect the fetal respiratory movements. At first the rate was increased somewhat but within 10 minutes it was reduced and the movements were not as uniform in intensity. By 15 minutes they were still more shallow about every fourth one being of normal strength. Rhythmicity, however, continued. In one instance the movements ceased at 42 minutes for 2 minutes and after their reappearance the rate was slowed one half or more with about every sixth one stronger than the rest. In this rabbit fetus the movements continued for over $1\frac{1}{2}$ hours and were still going when the experiment was stopped.

The rate varied greatly in different fetuses, in different species of animals, and in fetuses of varying maturity. In general the rate in dogs was less than in rabbits or rats and in premature animals it was slower than in ones

at term. Variations from 4 to 90 a minute were observed but in the few animals studied there seemed to be no rate characteristic for the species. Ether rapidly reduced the rate finally causing complete cessation. Sodium amytal slowed it gradually. For instance, rates of 30 to 40 per minute were reduced to 10 to 15 and finally cessation of respiration occurred.

2. *Uterine contractions.* In the reports of Rosenfeld and Snyder and of Eastman no particular mention was made of uterine contractions. We noted that in some animals operated upon at term uterine contractions were so vigorous that they interfered with our observations and photography of the fetal respiratory movements. In 2 rabbits labor began during the course of the experiment. Uterine movements were less bothersome in animals operated upon a few days before term and in ones that had been given theelin injections to prolong the gestation period. Contractions were seen very distinctly which gradually moved toward the vagina. The portion immediately behind the wave of contraction dilated or expanded. When ether was administered to the mother, contractions became less frequent and intense, finally disappearing entirely. Sodium amytal reduced the frequency and intensity of uterine contractions.

Since our investigations were initiated primarily in order to study the fetal respiratory movements, observation of uterine activity was more or less secondary. However, sufficient information was obtained to make us feel that this method could be used satisfactorily to study simultaneously the effects of anesthetics and analgesics upon uterine contractions as well as fetal respiratory activity. While the activity of the uterus during actual labor would not be recorded, always valuable information, nevertheless, would be obtained. Furthermore, in some instances, as happened in some of our rabbits, labor might begin during the course of an experiment in which instance the effects of anesthetics and analgesics upon the parturient uterus could be studied. Finally, it would be possible to induce labor in order that such observations might be made.

EVALUATION OF STUDY

The method described offers several advantages. Primarily it is of value because it permits tests to be made upon laboratory animals rather than humans. Taking motion pictures makes it possible to preserve the observations for reference. Thus, experiments may be reviewed, checked, and detailed studies made of the character and quality of the movements. Also demonstrations may be made before medical groups. The chief value of the method, however, lies in the fact that it is possible not only to determine the effect of various preparations upon the uterus but also upon the fetus *in utero*.

Certain disadvantages have been found. The method is subject to personal error in that it depends entirely upon observations made with the eye. Because of this it is difficult to continue the studies for extended periods and the use of moving pictures for a protracted time is expensive. Furthermore, it is extremely hard to time the movements accurately.

Objections may be raised about the manner of preparing the animal for the experiment. Thus, doubt may be expressed about the occurrence of fetal movements in unoperated upon animals. Rhythmic movements of this nature have been observed in unoperated upon laboratory animals and humans (Ahlfeld, Rosenfeld and Snyder) and graphic records of these movements through the unopened abdominal wall have been published (Ahlfeld, Reifferscheid). In the face of this, surely such factors as mechanical stimulation by operative manipulations, immersing solutions, temperature variations due to inadvertent exposure of the uterus to the air and heat of artificial illumination, cannot be incriminated very well. As far as the solutions are concerned they are generally considered physiologic enough to be suitable for experimental and clinical purposes. The solutions are kept at body temperature and the heat caused by illumination can be controlled easily. Drying can be prevented by total submersion and, in fact, there is less glare when this is done. Interference with the uterine blood supply can be eliminated by care in setting up the preparation. Another criticism is that the release of intra-

abdominal pressure upon the uterus by opening the peritoneal cavity may affect uterine contractions or fetal respiratory movements. Since the action would be one of retardation rather than stimulation we do not consider this factor of much importance.

Perhaps the most pertinent criticism pertains to transection of the spinal cord. It is possible that this may interfere with the innervation of the uterus and in turn with normal uterine contractions but one cannot conceive of any particular direct effect upon the fetus as a result of this act. The uterus is thought to possess an inherent capacity for rhythmic contraction. Under normal conditions uterine activity is governed by both motor and inhibitory nervous influences which probably are of reflex or central nervous origin. When the cord is transected the only effect to be expected would be removal of the central nervous influences. How great this is one cannot state definitely. The effects caused by transection of the cord and spinal anesthesia are similar in many respects. Several observers have studied this problem in relation to the uterine contractions during labor. Some of their conclusions have been somewhat contradictory. Bourne and Burn, after reviewing the subject carefully and making hystero-graphic studies, concluded that while under spinal anesthesia "the rhythm of the uterine contractions was not perceptibly altered there was a maintained rise of pressure in between each uterine contraction." In other words uterine tone was increased. Since the rate and rhythm of the contractions are not interfered with it appears that cord transection may be used satisfactorily in testing the stimulating or depressing effect of anesthetics and analgesics on uterine contractions, especially after determining what constitutes normal for the cord animal.

In spite of certain objections it is our opinion that this method is of distinct value in testing the action of the various agents upon fetus and possibly uterus. Studies along these lines should be continued and the method used until a better one can be devised. It is hoped that an instrument can be developed to record graphically the volume changes of the uterine musculature and the fetus *in utero*

in animals prepared in this manner. Perhaps an instrument devised by Fenning to record graphically small changes of volume can be adapted to this particular purpose. We intend to carry out investigations to determine if this is possible.

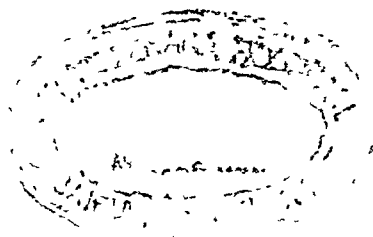
SUMMARY

There is need for greater use of precise methods to determine the effect of anesthetics and analgesics on uterine contractions and on the fetus. As far as the uterus is concerned hystero-graphy is the method of choice at present. Especially is this true of external hystero-graphy since it is reasonably accurate, simpler, safer for the patient, and less subject to criticism. A procedure recently described by Rosenfeld and Snyder offers great possibilities in studying the effects of anesthetics and analgesics upon the fetus. Experiences with this method are related and the observations of Rosenfeld and Snyder regarding the existence of apparently physiologic intra uterine respiratory movements which are depressed or stopped by some of the anesthetics and analgesics are confirmed. There is evidence that this method may be of value in studying the effects of these agents upon uterine contractions also. Direct and color motion picture observations upon animals anesthetized by cord transection are reported and the advantages and disadvantages of the method are discussed. In order to obtain more accurate data there is need for an instrument which will record these movements graphically. It is possible that this may be accomplished in the near future by using an instrument recently devised by Fenning to record graphically small changes of volume. Further studies along these lines are being pursued.

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INGUINAL HERNIA

I The Anatomy of the Region

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OVER a period of several years the authors gathered data on what were at first regarded as unusual types of abdominal musculature. As records accumulated the incidence of the "unusual" cases became high, it was soon learned that they were not exceptional, but merely different from the arrangements conventionally described and figured. A study was then begun on the abdominal layering of consecutive specimens, 123 specimens have been studied to date, a number which seemingly includes all types of musculoaponeurotic layers and gives a reliable concept of the incidence of each. In the following account we shall present those features of the anatomy which are regarded as surgically important. In this selection the writers were dependent in part on the judgment of Dr. Leo M. Zimmerman, whose presentation of the principles of hernial repair, appearing in a separate article in this journal, is correlated with the anatomical discussion.

MATERIALS AND METHOD

The descriptions are based upon records obtained from the dissection of 125 consecutive specimens (250 inguinohypogastric regions).¹ The illustrations represent the anatomy of 3 selected cases. Specimen A represents the commonest type of internal oblique muscle. Specimen B represents a less common arrangement in which the inguinal parietes are almost entirely aponeurotic, upon the opposite side of this specimen Dr. Zimmerman carried out the operation which is illustrated in his article. Specimen C is dissected to demon-

strate the relation of the 3 aponeuroses to each other and to the rectus muscle. Figures 6 and 7 are diagrammatic composites based upon our records of the internal oblique and transverse abdominis muscles.²

DESCRIPTION OF SPECIMENS ILLUSTRATED

Specimen	Race	Age-Years	Height inches	Weight pounds	File number
A	White	57	68	150	1
B	White	53	65	190	2-3-4
C	Negro	61	68	150	5

EXTERNAL OBLIQUE MUSCLE

In the inguinohypogastric region the external oblique muscle is entirely aponeurotic. It is usually considered as forming the major portion of the rectus sheath in this region yet actually contributes relatively little to that structure (Fig. 5), it is readily separable from the aponeurosis of the internal oblique along a semilunar line which lies progressively nearer the linea alba as the pubic crest is approached (Fig. 1), the two lines frequently coinciding just above the pubic symphysis.

The aponeurosis of the external oblique is regularly described as having a pubic insertion additive to the two crura of the subcutaneous inguinal ring, this extra band, the reflected inguinal ligament is composed of a group of fibers derived from the deep surface of the aponeurosis, which do not terminate at the middle line of the body in the substance of the linea alba but, crossing to the opposite side, insert into the pubic crest and tubercle. Actually, the reflected ligament rarely occurs, it was present bilaterally in less than 1 per cent of the subjects unilaterally in 3 per cent. When present it overlies the strong rectus muscle and therefore could be of no service in preventing direct inguinal herniation.

¹Permanent records were obtained of the extent and character of the inguinal layers in each subject by outlining upon glass with wax pencil and then transferring to tracing paper all features of interest. Details of structure were then added free hand to the sketch while a written description was being prepared by an assistant. Supervised student dissections were usually satisfactory for study and record but whenever a dissection offered difficulties or presented apparently novel features, it was completed by the authors.

Contribution No. 259 from the Anatomical Laboratory of Northwestern University Medical School

²Another article by the present authors on the subject of a general anatomy will appear in the Anat. Record 1938 70 No. 4

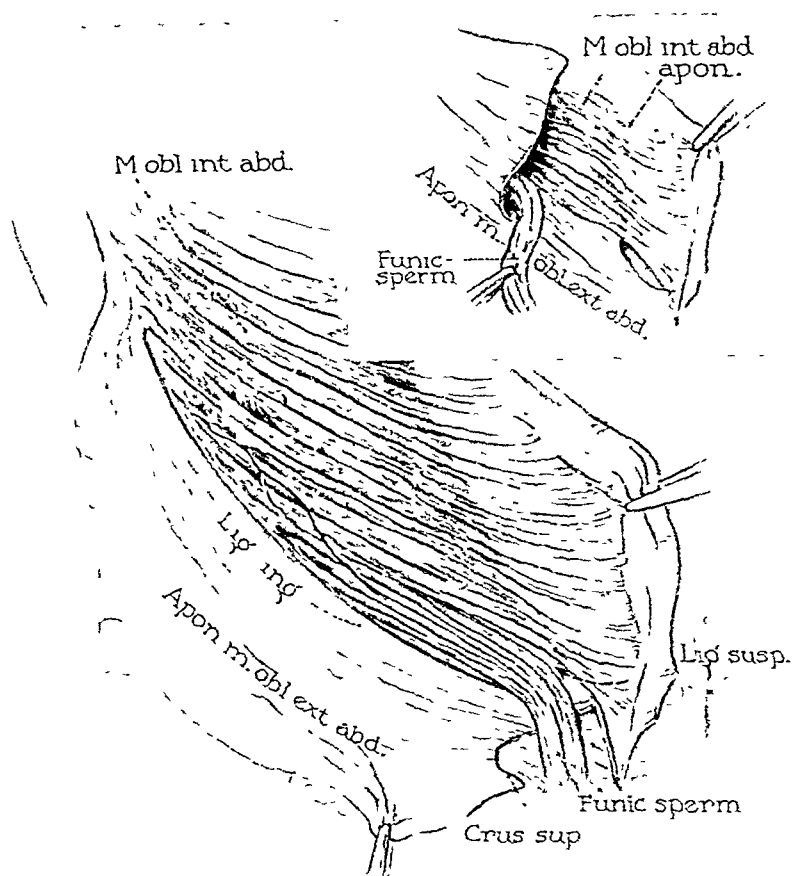


Fig 1 Specimen A The usual type of internal oblique muscle and aponeurosis (Fig. 6), the stratum is exposed by reflection of the external oblique. An "aponeurotic inguinal falx" is artificially produced by dislodging the cord and its cremasteric investment from the sulcus in the internal oblique muscle, a cleft (at arrow) is thereby produced, which sets off a falciform band from the cremasteric fibers. a, insert, Anatomical demonstration of the use of an intumed flap of the external oblique aponeurosis to strengthen the region of direct inguinal hernia (see following article)

INTERNAL OBLIQUE MUSCLE

The internal oblique is almost invariably described and figured as a layer which is entirely muscular in its inguinal portion, aponeurotic only in the hypogastric region, where it contributes to the formation of the rectus sheath. It is, according to our observations, generally true that the stratum is chiefly muscular, the latter two-thirds being made up of muscle fibers, the medial one-third of aponeurosis (measured to the lateral border of the rectus muscle). But there are notable exceptions: the muscle may be short in either transverse (Fig. 2) or vertical direction (Fig. 6), al-

though, in most instances (97 per cent) it extends inferiorly to the spermatic cord.

In those specimens in which the inferior, or funicular, portion of the internal oblique is aponeurotic (Fig. 2) the true structure of the layer is evident. The stratum is complete, is attached, without breach or hiatus, to the inguinal ligament. It contains no "aponeurotic inguinal falx," i.e., no thickened falciform band exists (even where the layer is muscular) until the spermatic cord has been retracted and the cremasteric fibers sharply separated from those just above; the superior wall of the cleft thus produced is the only

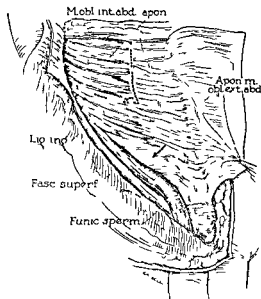


Fig 2 Specimen B Dissection as in Figure 1. An uncommon type of internal oblique in which the inguinal part of the layer is more aponeurotic than muscular and almost entirely aponeurotic over the abdominal inguinal ring. The margin of the subjacent transverse muscle is indicated by broken line. The position of a hernia adiposa by arrow (Figs 3 and 4).

observable representation of a falx. Therefore, such a band must be regarded as an artifact, evident only after the musculofascial layer has been separated into two distinct parts, one above, the other below the cleft.¹

Actually, then, since the aponeurosis passes anterior to the rectus muscle the so called aponeurotic inguinal falx is merely an area in the anterior lamina of the rectus sheath rendered more prominent than the surrounding tissue through its insertion into bone. Directly posterior to this portion of the aponeurosis is situated the rectus muscle so that even if the falx were a markedly thickened band, it could not be reasonably described as a structure efficacious in preventing direct inguinal herniation of the abdominal contents.

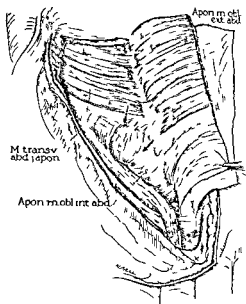


Fig 3 Specimen B Continued. An aponeurotic trans versus abdominis representative in the proportion of aponeurosis to muscle of almost 20 per cent of the cases (Fig 7) unusual in the thinning of its medial part which latter is set off from the thicker lateral portion by a falx form edge (at broken arrow). The thinner stratum covers the hernia adiposa (at unbroken arrow). Aponeurotic inguinal falx wanting.

When sutured to the inguinal ligament in herniotomy, the so called falx—which is merely part of the rectus sheath—is subjected to undue traction in all stretching movements of the abdominal musculature, this condition may in part account for the frequency of recurrence in hernia. It is our belief that such traction might be obviated, in hernial repair, by suturing a flap of the aponeurosis of the external oblique muscle to that of the trans versus abdominis (see demonstration in Fig 1a), this is accomplished by using the cleft in the internal oblique as the route by which the two layers are brought into approximation. The full discussion of the technique and of the results of its employment will be found in the article by Dr. Leo Zimmerman.

Beneath the internal oblique proper is an accessory internal oblique muscle (Chouke), present in 40 per cent of 250 inguinal regions studied.² It has doubtless been mistaken in

¹This dissection is based upon the surgical dissection of the internal oblique muscle of the female, given by the author in the paper on the inguinal region, published in the *Annals of the New York Academy of Medicine*, 1934, Vol. 34, No. 1, p. 1. The dissection is based upon the surgical dissection of the internal oblique muscle of the female, given by the author in the paper on the inguinal region, published in the *Annals of the New York Academy of Medicine*, 1934, Vol. 34, No. 1, p. 1. The dissection is based upon the surgical dissection of the internal oblique muscle of the female, given by the author in the paper on the inguinal region, published in the *Annals of the New York Academy of Medicine*, 1934, Vol. 34, No. 1, p. 1.

²Disc. by Chouke as occ. in 40 per cent of cases examined (Anat. Record 1934 1935 61 347-349).

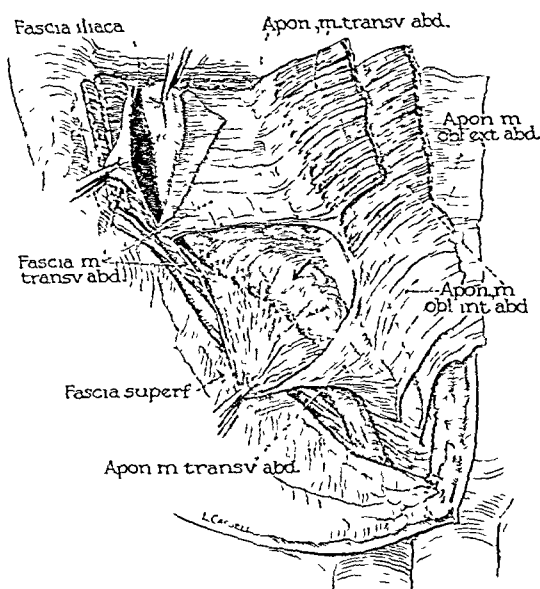


Fig 4 Specimen B Dissection concluded Showing the heavy internal layer of investing fascia of the transversus abdominis muscle (transversalis fascia), which, in turn, is incised transversely to expose the preperitoneal layer of connective tissue (and the contained hernia adiposa, at arrow), incised vertically, to demonstrate its continuity with the fascial covering of the iliacus muscle. The muscle fibers of the transversus abdominis have been turned medially to a point where the transversalis fascia fuses with the aponeurosis of the transversus abdominis muscle

the past for the transversus abdominis muscle, and its unrecognized presence may account for the fact that usually the latter is described and figured as extending farther inferiorly than it actually does

TRANSVERSUS ABDOMINIS MUSCLE AND TRANSVERSALIS FASCIA

The transversus abdominis is usually more aponeurotic in the inguinal region than is the internal oblique, thus although in 97 per cent of the cases, the muscular part of the internal oblique extended inferiorly as far as the spermatic cord (Fig 6), in only 3 per cent did the muscular portion of the transversus abdominis reach that level (Fig 7), in 62 per cent, it terminated within the superior half of the inguinal region, in 7 per cent it did not reach the anterior superior spine of the ilium, that is, was not inguinal at all; in approximately 19 per cent of the cases the layer was almost as aponeurotic as the external oblique

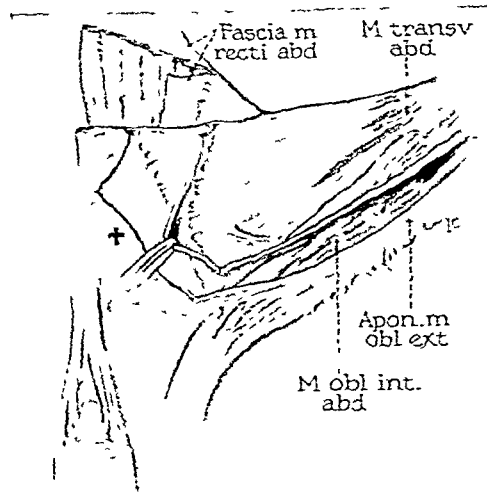


Fig 5 Specimen C Dissection of inguinal layer, sectioned 5 centimeters above the superior border of the pubis. The aponeuroses of the external and the internal oblique muscles remain only at their medial and inferior borders. The rectus muscle has been retracted from the anterior lamina of the rectus sheath to demonstrate the manner in which the investing "rectus fascia" arises from the aponeurosis of the transversus abdominis muscle. The line of fusion of the aponeurosis of the internal oblique with that of the transversus abdominis is vertical, both layers are unbroken, there being no margin which resembles an "aponeurotic inguinal falx". The line of fusion of the three aponeuroses occurs within the territory of the anterior lamina of the rectus sheath, each contributing, to a different extent, to the formation of the latter (marked by +)

in the same subject, the muscle fibers terminating at or near the interspinous line.

In the medial direction, the limit of the muscular part of the layer also varies considerably. In only about one-half of the cases do the muscle fibers form the lateral two-thirds of the stratum in the inguinohypogastric area and the aponeurosis the medial one-third (Fig 7), as is quite consistently the arrangement for the internal oblique.

The medially placed tendinous plate is, in almost all descriptions, correctly termed aponeurosis; but, curiously enough, the inferior continuation of the same structure is called a fascia, or specifically, the "transversalis fascia". That the two are merely areas of the same layer is clearly evident in those cases—numerous in the laboratory, rare in books and journals—in which the muscle fibers terminate at a high level, leaving a broad expanse of the stratum entirely without

between the thickness of the transversalis fascia and the rectus fascia—a thin slip of fascia that originates from the fused aponeurosis of the transversus and transversalis fascia and passes medially to invest the rectus muscle (Fig. 5). This fascia of the rectus muscle is a distinct structure, entirely separable from the sheath of the same muscle, related to it only in being a derivative of one of the three contributory aponeuroses to the sheath. This thin envelope may be the “transversalis fascia” upon which some authors state that the rectus muscle rests. This layer is comparable to the fascia which forms the immediate investment of muscles in other regions of

the body, e.g., to the leaf of cervical fascia which divides to enclose the sternocleidomastoid muscle, to the layer of pectoral fascia (costocoracoid membrane) which splits to invest the subclavius muscle. Except for it, the rectus muscle rests posteriorly upon preperitoneal connective tissue. After having contributed this muscle fascia to the rectus, the aponeurosis of the transversus abdominis muscle forms, for a short distance, the only anterior component of the rectus sheath (Fig. 5); it is next joined by the aponeurosis of the internal, finally by that of external, oblique muscle. The latter conjunction is accomplished near the linea alba.

Aponeurosis incised
along medial edge
of external ring

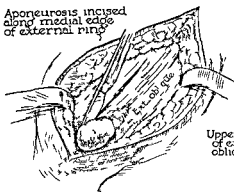


Fig 1

Canal opened,
exposing sac

Upper flap
of ext
oblique

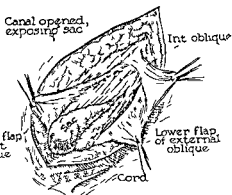


Fig 2

Transversalis fascia
dissected from sac

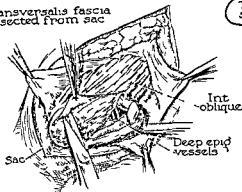


Fig 3

Transversalis fascia
sutured to the
inguinal lig

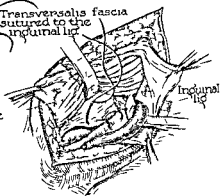


Fig 4

Lower flap of external
oblique aponeurosis
incised at the inter-
nal ring

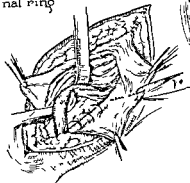


Fig 5



Flap from ext
oblique, aponeu-
rosis sutured
down to the trans-
versalis fascia
beneath the
int oblique

Fig 6

Upper flap of the ext
oblique aponeurosis
sutured over cord
to the ext surface of
the ing lig

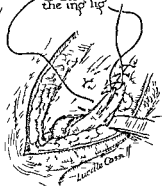


Fig 7

CLINICAL SURGERY

INGUINAL HERNIA

II. The Surgical Treatment of Direct Inguinal Hernia

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THERE is a tendency among surgeons to view the results of the operative treatment for inguinal hernia with complacency. This satisfaction, however, is found to be unjustified whenever the test of actual postoperative follow-up is applied. The results of surgery in direct hernia are particularly disappointing. In a recent publication, Andrews and Bissell presented statistics from their own and other clinics showing recurrences in over 25 per cent of the cases in those series of direct hernias in which follow-up examinations were made. On the basis of these figures, they confess the failure of surgery as a treatment for the usual forms of direct hernia and advise against surgery in these cases, particularly since the discomforts and dangers of an otherwise harmless condition may be aggravated by unsuccessful operation.

Acceptance of defeat by surgeons does not help to solve the direct hernia problem. The recognition of the type of hernia present, before the canal is opened, is frequently difficult, even if the diagnostic criteria described by Andrews are utilized. I must confess that my pre-operative impressions, derived from both the patients' complaints and my own findings, are wrong sufficiently often to make me unwilling to advise treatment on the basis of the type of hernia I expect to find. Andrews mentions the medicolegal aspect of the problem, with reference to the inability of direct hernia sufferers to obtain employment. The other side of the picture also merits consideration. Many of these cases develop during employment and are treated as compensable conditions. Confession of inoperability would imply permanent disability and create a tremendous insurance problem. The essential lesion in direct hernia presents difficulties which, though perplexing, do not seem insurmountable. They should challenge us, rather, to continue to seek new methods until a more satisfactory solution to the problem has been found.

In seeking an explanation for the distressingly high incidence of recurrences following operation

for direct hernia, one factor would seem to be the failure of many surgeons adequately to differentiate, in their treatment, between hernias of the direct and the indirect variety. Indirect hernia is recognized as a peritoneal protrusion through the internal inguinal ring, in which failure of obliteration of the processus vaginalis is at least an important, if not determining factor. Direct hernia, on the other hand, is an actual rupture or stretching of the structures forming the floor¹ of the inguinal canal. In view of the totally different etiology and pathology of the two forms of hernia, it would seem that an appropriately different attack would be indicated, directed in each case against the fundamental lesion present. Nevertheless, one sees in the literature, as well as in the operating room, the same procedures used for both types of inguinal hernia.

Although direct hernia is always an acquired lesion, it has a predisposing anatomical background of congenital origin. In a recent study of the anatomy of the inguinal region conducted in the Department of Anatomy of Northwestern University Medical School,² the internal oblique muscle was usually found to be a complete musculofascial sheet extending down to the pubic spine. A narrow cleft separated the cremasteric portion of the muscle from its main body. The space, therefore, between the lower arching border of this muscle and Poupart's ligament was completely occupied by the spermatic cord, and no portion of the inguinal floor was unsupported by muscle. The downward extent of the fleshy fibers of the transversus abdominis muscle was much more variable, but it almost always ended higher than did the internal oblique. Continuing downward from the free lower muscular border was an aponeurotic membrane which completed the musculofascial sheet of this layer. This aponeurosis, usually designated the transversalis fascia,

¹The term "floor" is used to designate the posterior wall of the inguinal canal in accordance with surgical usage. In the supine position, as on the operating table, the posterior wall does form the floor of the canal.

²Anson B J, and McVay, C B. The anatomy of the region of inguinal hernia. Elsewhere in this journal.

extended down to the inguinal ligament and lay deep to the spermatic cord. It is the layer which comprised the floor of the inguinal canal.

The arrangement described, which may be considered the usual or normal, coincides with that usually encountered at operation in patients with indirect inguinal hernia. Under these circumstances, the inguinal canal is only a potential space which becomes further narrowed when the internal oblique muscle contracts and approximates itself to the inguinal ligament. Direct hernia is, not surprisingly, rare in persons with this type of abdominal protection.

In some of the specimens examined, however, the arrangement was different. The lower border of the internal oblique muscle ended at a variable distance above the pubis, leaving a triangular area, the so called inguinal triangle, bounded by the lower free border of the internal oblique muscle, the rectus sheath, and Poupart's ligament, in which the floor of the inguinal canal was unsupported by overlying muscle. In the anatomical study referred to above by actual measurements of 95 unselected specimens Anson and McVay found the length of the medial border of the triangle to be

Length in cm.	No. of specimens	Length in cm.	No. of specimens
0	15	3 0	12
0 5	4	3 5	2
1 0	12	4 0	2
1 5	14	5 0	4
2 0	18	6 0	2
2 5	30		

The specimen from which Figure 2 in the article by Anson and McVay is taken is an interesting example of abdominal wall in which the lower most fibers of the internal oblique muscle are wanting. In this subject, a direct inguinal hernia was found on the left side. On the right side although no hernia was present the arrangement of the muscles was identical. Poly¹ found a similar absence of the lower fibers of the internal oblique muscle in 15 of 50 dissected specimens the free border inserting into the rectus sheath from 1 to 3½ centimeters above the pubic spine.

The arrangement just described coincides with the findings at operation in patients with direct hernia, and probably explains the genesis of the hernia. Several observers have recorded this muscular deficiency during operations for direct hernia using various methods for determining the size of the defect. Poly¹, in 1912, actually measured the size of the inguinal triangle with a graduated uterine probe in 100 unselected cases of inguinal hernia. In these cases were included both the direct and the indirect varieties of inguinal hernia. He found that the length of rectus

sheath comprising a side of the triangle was as follows:

Length in cm.	No. of cases	Length in cm.	No. of cases
0	2	4	27
1	7	5	9
2	31	6	5
3	25	7	2

Andrews (3) measured the inguinal triangle in a series of 20 direct hernias and found that the average length of rectus sheath bordering it was 5 centimeters. Ssosan Jaroschewitch traced the margins of the triangle on sterile glass with a sterile pencil during operations for both types of inguinal hernias. The muscular defect was always larger in direct hernias than in indirect ones of the same size. In oblique hernias the lower fibers of the internal oblique muscle ran more nearly parallel with Poupart's ligament, and formed an obtuse angle with the rectus sheath. In direct hernias the angle approached 90 degrees, as the course of the lowermost fibers was almost transverse.

For some time, I have been mapping the boundaries of the inguinal triangle at operation, by a slightly different method. Using a coarse meshed, wax impregnated gauze (paresine gauze), patterns are cut of the muscle defect. With only rare exceptions, in direct hernias a triangle of material size has been present, in which the limb formed by the rectus sheath has ranged from 2 to 7 centimeters. In indirect hernias, the triangle is long and narrow, its width coinciding almost with the diameter of the cord. It is usually possible to tell at a glance as soon as the aponeurosis has been divided, what type of hernia one is dealing with by the type of internal oblique muscle present.

From these repeated observations the conviction grows that the underlying predisposing anatomical basis for direct hernia consists of a congenital absence of adequate muscular support for the lower portion of the inguinal canal. This explains the fact that most men go through lifetimes of hardest labor without developing direct hernia, while others who are relatively inactive, have direct hernias before middle age is reached. It also accounts for the frequently bilateral distribution of direct hernia since the anatomical structure is usually symmetrical on the two sides. The objection might be raised that the muscle defect is secondary the lower end of the internal oblique having been pushed upward and attenuated by the pressure of the sac. This is disproved by the fact that similar defects do not accompany in direct hernias of the same or larger size. Nor is size of triangle proportional to the size or duration of the hernia. And in cases with well developed lesions on one side and beginning ones on the other a symmetrical triangular defect is found.

SURGICAL TREATMENT

The surgical treatment for inguinal hernia, whether of the oblique or the direct variety, usually consists of operation by the Bassini technique or one of its numerous modifications. The essential step in all these procedures is the suture of the internal oblique muscle¹ to the inguinal ligament. This newly formed floor may then be reinforced with one or more of the other layers of the abdominal wall. The inadequacy of these methods, so far as direct hernia is concerned, is attested by the high incidence of recurrences in their wake. There are two apparent reasons for these failures. First, the rent in the floor of the canal, that is, in the transversalis fascia, which is the basic lesion in direct hernia, has not been repaired. Suturing the heavier overlying muscles gives the operator a false sense of security as to the adequacy of his repair and often leads him to omit the one step that logically should initiate any operation for direct hernia.

The second reason for the inadequacy of the conventional operations lies in the failure of permanent union between the internal oblique muscle and Poupart's ligament. Experience and experiment have repeatedly shown that confidence in the permanence of such union is misplaced. Seelig, Gallie and LeMesurier (6), and others have demonstrated that muscle and fascia do not unite firmly when sutured together. At reoperation in recurrent hernias, almost invariably, these structures are found to have returned to their original positions, as if they had never been sutured.

The essential problem in the repair of a direct hernia is the closure of a defect in the fascial floor of the inguinal canal. The predisposing cause of this rupture, as stated, is a congenital absence of adequate muscular support. Inasmuch as there are no methods by which muscle can be made to grow where it is deficient, the defect must be repaired by some type of fascial plastic procedure which will provide sufficient resistance to withstand the intra-abdominal pressure. To be effective, the fascial reinforcement should be in

immediate apposition with the newly repaired transversalis fascia. There should be contact between the two layers over a broad surface, without tension and with no interposition of muscle or fatty tissue.

There are several methods by which these requirements can be fulfilled. They are approximated in the "white fascia" operation of Andrews (1, 2). Here, however, the reinforcing aponeurosis is separated from the transversalis fascia by whatever internal oblique muscle there is, and it still lies in the position of the roof of the canal rather than the floor. The method of fascial strip plaiting popularized by Gallie and LeMesurier (7) has found wide adoption. This operation, however, is not easy. It requires a separate intervention to provide the fascial strips. The fascial sutures are cumbersome and necessitate very coarse needles with their attendant trauma to the tissues they penetrate. The strips have been detached from their blood supply and thus act as foreign bodies. The incidence of infection in reported series of such operations is material. That this procedure is not the final solution to the problem of difficult hernia is attested by the recent publication of Burdick, Gillespie, and Higinbotham in which a recurrence rate of 29.1 per cent was reported in a total series of almost 1500 cases operated upon by the fascial strip method. There were 310 primary direct inguinal hernias in this series with recurrences in 25.8 per cent.

Other methods of fascial transplantation include the free transplantation of autogenous or preserved fascia. The former is preferred for obvious reasons, and we have used it to good advantage in difficult recurrent hernias. The fascial patch is taken from the fascia lata of the thigh and insinuated between the transversalis fascia and internal oblique muscle. Its disadvantages lie in the fact that a second incision is required and the transplant is detached from the sources of its blood supply.

Pedunculated fascial flaps have also been used for hernial repair. Turner has recommended cutting a rectangular flap from the fascia of the thigh, just below Poupart's ligament, which is left attached superiorly. The inguinal ligament is then separated from the femoral vessels, and the flap is turned up under the ligament, to cover the inguinal region. Unfortunately, the fascia lata is weakest at this point, and is perforated at the fossa ovalis for the passage of the saphenous vein. The inguinal lymph nodes lie on the fascia in this region, interference with which might prove disastrous. Furthermore, there is danger to the femoral vessels both during the operation and in leaving

¹The term "conjoined tendon" is omitted advisedly because it is incorrect and confusing. Two separate structures are described bearing this name. In anatomical descriptions, it is defined as the "aponeurotic inguinal falx," a fasciofascial band of fascia derived from the insertions of both the internal oblique and transversus abdominis muscles, which attaches to the pubic crest, tubercle, and laterally along the pectineal line for a distance of 3.75 centimeters. It lies deep to the spermatic cord and reinforces the transversalis fascia in forming the posterior wall of the inguinal canal. As stated in the article by Anson and McVay, a careful anatomical study revealed no such structure.

In surgical literature, the term "conjoined tendon" usually refers to the lower arching fibers of the internal oblique muscle. As pointed out by Anson and McVay, this free margin is actually an artefact. It is almost invariably muscular rather than tendinous, at least in part, and it does not fuse with the insertion of the transversus abdominis for some distance medial to the edge of the rectus muscle. In other words, it is neither conjoined nor tendinous. The interests of clarity would be better served, therefore, if the term "conjoined tendon" were abandoned.

them without their fascial protection. The procedure of Wangenstein, of turning up a pedunculated flap of fascia lata with its attached tensor muscle is of unquestioned value in repairing huge abdominal or inguinal defects. It is too extensive a procedure, however, for the ordinary hernias, even of the direct variety.

For several years I have used a simple plastic step which apparently meets the requirements for the repair of most direct hernias. The method consists of first freeing and closing the transversalis fascia, then reinforcing it with a patch from the lateral flap of the external oblique aponeurosis. This portion of the aponeurosis is usually present as a firm white fibrous structure, many times stronger than the original fascial floor of the inguinal canal. The flap retains its normal attachments, so that its circulation and its viability are unquestioned. It is insinuated between the transversalis fascia and the internal oblique muscle, in direct apposition with the former structure. There is, therefore, broad approximation of fascia to fascia without interposed muscle tissue. The operation is technically easy, requires no second incision or wide dissection and takes no more time than the usual methods of herniorrhaphy.

TECHNIQUE

The steps of the operation are illustrated in Figures 1 to 7. The usual inguinal incision is made and the canal is opened by dividing the aponeurosis of the external oblique along the medial crus of the external ring in order to provide a lateral flap wide enough to be used later for covering the hernial defect. The spermatic cord is dissected to rule out a concomitant indirect hernia and is then retracted laterally. The direct hernial sac is gently lifted with forceps and freed in its entire circumference by dividing with dissecting scissors the attenuated fascial fibers coursing over it. When it has been completely liberated, a free border of transversalis fascia, extending from the pubis to the deep epigastric vessels has become defined.

The sac, as a rule, is wide and dome shaped and is often covered with a thick layer of extra-peritoneal fatty tissue. Since it is merely the presenting portion of the peritoneal lining bulging through the weakened floor, and not the essential constituent of the hernia nothing is gained by opening removing suturing, or plating the sac. Its proximity to the bladder renders such steps dangerous as well as unnecessary. Instead, the sac is merely inverted into the retroperitoneal space, and the transversalis fascia is sutured down to Poupart's ligament over it. Because of the

mobility of the transversalis fascia, this can always be accomplished without tension. When completed the floor of the canal from the pubic spine to the inferior epigastric vessels has been restored and the hernial bulge disappears from view.

The newly reconstructed floor is then reinforced (Figs. 5, 6) with a flap cut from the outer leaf of the aponeurosis of the external oblique muscle. This aponeurotic flap is incised obliquely from above downward, opposite the internal ring and the patch thus formed is swung beneath the cord. The internal oblique muscle is gently elevated on a blunt retractor, and the patch insinuated between it and the subjacent transversalis fascia. It is fixed with interrupted sutures and the muscle is allowed to fall back to its normal position covering the suture line as a trapdoor. No sutures are placed in the muscle layer.

In those instances in which the insertion of the internal oblique muscle is fibrous rather than muscular, the cleavage plane between it and the transversalis fascia is less well defined. Nevertheless, in the anatomical studies referred to, it was found that these layers can always be separated without difficulty. If, however, in such cases the flap were to be brought anterior to the internal oblique aponeurosis, union would probably take place since both layers are fascial.

The final step in the operation consists in dropping the cord back upon the strongly reinforced inguinal floor and restoring the roof of the canal. This is done by bringing the medial flap of the external oblique aponeurosis over the cord and suturing it to the external surface of Poupart's ligament (Fig. 7). To avoid relaxation of the wall at the site of division of the lower flap an imbrication stitch is placed at this point and the upper flap is brought down over it with a continuous suture. To reconstruct the external ring this suture ends with a pursestring in Scarpa's fascia bringing it snugly about the cord at the lower end of the canal. In the occasional subject in which the lower flap of the aponeurosis seems inadequate as a reinforcement for the inguinal floor the upper flap may also be brought beneath the cord leaving the latter structure immediately beneath the skin. The cutaneous incision, finally, is closed and a pressure spica of elastic bandage or stockinette is applied.

The operation can be done under local or general anesthesia. It requires relatively little time for its completion and inasmuch as no tension is required in placing the sutures there is no contra-indication to operating upon both sides of a bilateral hernia at the same sitting. In such

instances, a single transverse, suprapubic incision joining the upper margins of the external rings may be used with advantage. As Andrews has pointed out, the purely fascial herniorrhaphies are followed by relatively little postoperative pain. In repairs of the type described, it is not at all uncommon for patients to go through the entire postoperative period without requiring opiates for relief of pain.

When brought from the operating room, the patients are placed in a slightly flexed position, by elevating the backrest and raising the knees to avoid the discomfort from tension on the wound. Fluids are allowed post nauseam and food as soon thereafter as desired. The patients are permitted to be out of bed as soon as pulse, temperature, and general condition warrants. This usually means from 1 to 3 days in bed. The average period of recumbency is about 48 hours. The patients walk as early as they wish and are discharged from the hospital 7 to 10 days after the operation. Work is resumed any time after 4 weeks. As a rule, no limitations are placed upon the type of work done and no supports are prescribed except in elderly patients, in recurrent cases, or in unusually large hernias.

RESULTS

The operation above described has been done in 90 consecutive direct hernias during the past 6 years. Every effort has been made to follow these patients by actual personal periodical re-examination, for as long a period as possible after operation. Of the total number, I have been able to follow 59 for a minimum period of 1 year. The interval between operation and the latest examination in these cases has been:

Follow-up mos	Cases
12 to 18	20
18 to 24	6
24 to 30	10
30 to 36	7
36 to 48	10
Over 48	6
Total	59

In these 59 cases which have been followed for a minimum period of 1 year, there have been 6 recurrences, an incidence of 10.2 per cent. This figure, while still high, compares very favorably with that usually reported in similarly controlled series of direct hernias treated by conventional methods. Nor is this figure to be looked upon as the irreducible minimum. It is significant that 3 of the 6 failures occurred during the first year the method was used, which would suggest that technical considerations were partly responsible.

The exercise of some selection of the cases to be treated would probably further reduce the incidence of recurrence. This does not imply, however, a return to the orthodox procedures, but rather that even more radical methods be used for the most difficult and unfavorable cases.

It is of interest that 5 of the 6 recurrences were in patients with bilateral hernias, and all developed within a year following the operation. Four of these patients are working and apparently are not seriously incapacitated because of the hernias. I have re-operated upon the 2 others. One, an obese middle-aged man with bilateral hernia, was found to have a diffuse bulging through the inguinal floor. The fascial flap had apparently healed in place, but was of insufficient strength to withstand the abdominal pressure. The other originally had a diverticular type of direct hernia. At re-operation, a small, well defined hiatus in an otherwise firm fascial floor was found.

ADEQUACY OF METHOD

In principle, adequate repair of direct inguinal hernia requires, first, the closure of the defect in the transversalis fascia which constitutes the essential lesion. This fascial layer must then be strengthened by superimposing upon it a patch of firm, fibrous tissue. If a pedicled flap is used, it should be brought up from below, since any such flap derived from the upper leaf of the external oblique aponeurosis or the rectus sheath would, of necessity, be separated from the transversalis fascia by whatever internal oblique muscle there is.

The method described fulfills these requirements. It consists of isolation and reduction of the sac without opening it; of suture of the transversalis fascia to the inguinal ligament; and of reinforcement thereof with a flap derived from the lateral leaf of the aponeurosis of the external oblique. Only white fascia is used throughout, and the fascial layers are approximated to one another over a broad surface, without tension, with no interference with their blood supply, and without the interposition of muscle. The mobility of the transversalis fascia permits its being brought down to the inguinal ligament without difficulty. The outer leaf of the external oblique aponeurosis is almost invariably present as a good, firm, fibrous structure, from which the reinforcing flap may be taken. If this layer appears inadequate, it may be supplemented with the upper leaf of the aponeurosis. If the defect to be closed is too large, or the available tissues inadequate, the answer cannot be found in a return to the usual hernial operations, but must be sought in some type of

more radical transplantation as, for instance, of the iliotibial tract

SUMMARY

The usual operations for direct hernia are inadequate, as is indicated by the high rate of recurrences recorded whenever follow up studies are made. Their failure lies in neglecting to repair the defect in the floor of the canal, and in their dependence upon union between muscle and fascial tissues. A simple procedure is described in which the fascial floor is first sutured, then reinforced with a flap of firm fibrous fascia derived from the outer leaf of the aponeurosis of the external oblique muscle. No sutures are placed in the internal oblique muscle. The fascial structures are approximated over a broad surface, without tension and without the interposition of muscle. This method meets the requirements for most direct hernias. It has been used in 90 consecutive direct hernias during the past 6 years. Actual follow up re examinations at intervals ranging from 1 to 5 years in 59 cases revealed 6 recurrences, an incidence of failure of 10.2 per cent.

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TOTAL TENDON TRANSPLANT FOR SLIPPING PATELLA

A New Operation for Recurrent Dislocation of the Patella

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RECURRENT dislocations of the patella (slipping patella) may be divided, for clinical purposes, into three types: (1) congenital, which is a true anomaly; (2) traumatic, which is the result of severe injury, and (3) rachitic, which is secondary to a marked genu valgum

The anomalies that occur in the congenital type are not confined to the patella but frequently involve the patellar ligament and the lower end of the femur. The posterior surface, instead of having two equal joint surfaces to glide over the condyles of the femur, is irregular sometimes to the point of being almost wedge-shaped. The surface of the lateral condyle over which the patella glides is flattened and altered from the normal rounded shape, and since it is not fully developed the patella is likely to displace laterally. The patellar ligament is lengthened and the attachment to the tibia lies lateral to the normal attachment. The outer strands are much stronger, while the medial strands have become weakened through disuse, often to the point of atrophy and ultimate loss. The lengthening of the patellar ligament results in a high position of the patella in relation to the knee joint. The effect of this position on the function of the knee joint will be explained later. Congenital anomalies vary in severity, at times being so mild as not to cause any serious disturbance in function. Frequently both knees are involved; sometimes the one may give rise to recurrent dislocations, while the other, even though markedly deformed, carries out its function without any disability.

The traumatic type of recurrent dislocation of the patella is relatively rare. It occurs as the result of severe injury which is practically always an indirect trauma. Most frequently it is the result of a forceful twist which brings the leg into abduction at the knee, with a resultant tear not only of the medial ligament of the knee but also of the entire medial fascia, so that the patella and patellar tendon are displaced laterally. Such a knee if permitted to heal with a gap in the fascia, particularly near the upper part of the patella, has a tendency to recurrent dislocation. A

traumatic recurrent dislocation of the patella, if allowed to go untreated indefinitely, gives rise to secondary changes in the quadriceps muscle, in the lateral ligament, and in the patellar tendon, and ultimately in the patella itself. These changes are the result of altered use and a certain amount of disuse. The quadriceps muscle becomes weak and atrophic; the patellar tendon is lengthened and displaced laterally; the lateral fascia and capsule are shortened and markedly thickened. The shape of the patella is altered; it becomes wedge-shaped, the thinner part being toward the medial margin and the base toward the outer margin. A severe, neglected, traumatic recurring dislocation of the patella may ultimately reach the point where it becomes chronic, that is, the patella becomes constantly dislocated with nearly complete loss of function.

The rachitic type of slipping patella is associated with a primary anatomical change, namely, a genu valgum. That some other factor plays a rôle is evident, for not all patients with genu valgum are subject to recurrent dislocations of the patella; however, a severe genu valgum and a lengthened patellar ligament will explain a recurrent dislocation of the patella. In severe deformities the lateral condyle may be immaturely developed, particularly on its anterior surface, so that the patella can slide over to dislocate.

REVIEW OF LITERATURE

Prophylaxis and conservative treatment are not considered in this paper. Before presenting the new type of operation for slipping patella and its advantages, it is pertinent to discuss the operations previously used and their shortcomings, as well as the prerequisites of the operation of choice, so that the operation which is to be described and recommended may be evaluated on the basis of definite criteria.

Numerous operations have been described for correction of recurrent dislocation of the patella. The number in itself predicates that the problem has not been solved. No attempt will be made to give a detailed description of each individual operative technique however, in order to give fair consideration to each and every procedure that has been devised, the methods have all been

reviewed and will be discussed under groups arranged according to anatomical classification.

The various types of operation are divided into 6 groups namely (1) those procedures which are directed against the relaxed median capsule, (2) those in which the fascia is transplanted, (3) those in which secondary muscles are used to hold the patella medially, (4) those in which free fascial transplants are used to hold the patella medially, (5) those in which the lower end of the femur is attacked, and (6) those in which the patellar ligament is transplanted.

Under the first group we consider the so called reefing of the median capsule and fascia. In the very earliest of this type of operation, the medial side of the capsule was scraped and scarified in order to bring about a contracture (Heller, 1850). The next procedure was to reef the median capsule and fascia (Hoffa and Gocht). This method was soon found to be insufficient to prevent recurrence, so the patella was freed at its lateral margin before the reefing was done (Tubby). Attempts were made to free the patella and to hold it in the medial displacement (Perkins) while Wright sutured the patella to the medial condyle. The benefit attained was ascribed to scarification (Schanz). Later emphasis was placed on extending the incision of the lateral fascia well up along the margin of the conjoint tendon (Perthes). To shorten the fascia and ligament on the medial side the longitudinal incision was made through the fascia, the margins were undermined and overlapped, imbricated and sutured (Murphy). The vastus internus was imbricated in a similar manner along with the fascia (Bevan—Fig 1 A).

These methods proved inadequate because, first they did not prevent recurrence of the dislocation in a high enough percentage of cases second, they did not correct the high position of the patella third, they did not offer any correction of the lengthened patellar ligament fourth, they did not keep the muscle pull of the quadriceps in a direct line so that it can exert its greatest force in carrying out normal function.

The second group attempted the correction by means of a transplant of the fascia. First an oval section was removed from the joint capsule on the medial side and this was then closed with sutures, drawing the patella medially (LeDentu). This operation was also combined with a reefing of the capsule. It was found necessary in many cases to make a second incision lateral to the patella through the fascia. With the drawing of the patella medially an open space resulted at the site of the incision. This was filled in by means

of a transplant removed from the medial ligament (Dickson—Fig 1, C). The best technique for carrying out this procedure is to transplant a long strip of the medial capsule, the fascia, and the vastus internus over the upper margin of the patella into the gap on the lateral side (Krogus—Fig 1, B). This was also used by others (Strater, Lorenz, von Ruediger, Rydygier, Klapp and Lueckerath). This type of fascial graft can be combined with a muscle graft (Frangenheim). Another type of fascial plastic operation includes the transplant from the inner side of the capsule to the external side with a reefing of the medial capsule and a shortening of the quadriceps (Conn). This second type of operation again permitted recurrences although in a smaller percentage of cases than with the first group (Kapel). The patellar ligament is not shortened by this method and, therefore, the patella does not assume its normal position. Furthermore, this type of operation is not applicable to the severe cases in which the patellar ligament inserts too far laterally on the tibia since it does not bring about a direct pull of the quadriceps upon the tibia thus permitting the ligament to shoot off at a marked angle from the patella to the tibia.

The third group comprises those operations which attempted the correction by operations upon the muscles particularly by means of transplants. An attempt was made to shorten the quadriceps by reefing the tendon and fastening the aponeurosis of the internal vastus to the patella under tension (Bardenheuer). This method was used by others (Hoffmann and Bunts). The direction of pull of the quadriceps was altered by fastening the semitendinosus to this muscle (Heusner). In addition to the semitendinosus, the gracilis was also fastened to the quadriceps by drawing it through the fascia of the vastus internus (Lanz). The gracilis was also fastened on to the patella in addition to reefing the capsule and transplanting the insertion of the patellar ligament medially (Whitelocke). The sartorius muscle was brought around the quadriceps tendon and fastened into the medial condyle. In this way the sartorius acted as a sling to hold the patella medially (Hoffa and Gocht). A combination of fascial plastic and tendon transfer from the outer to the inner side has been attempted (Pasquale del Torto). The object of these muscle transplants was an attempt to strengthen the weakened quadriceps and to draw the patella medially. The objection to this method, aside from being a highly involved procedure and technically difficult to execute is that the mechanical forces that draw the patella laterally are much greater than

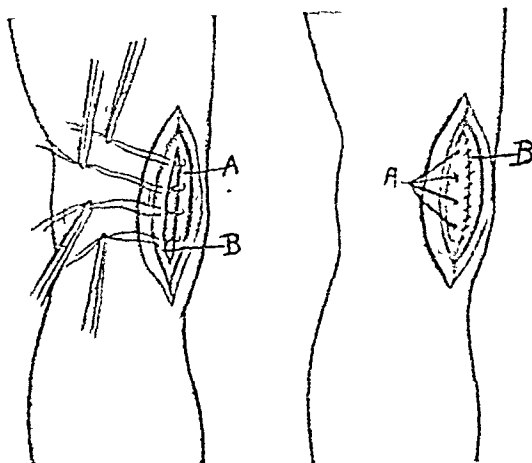


Fig. 1, A.

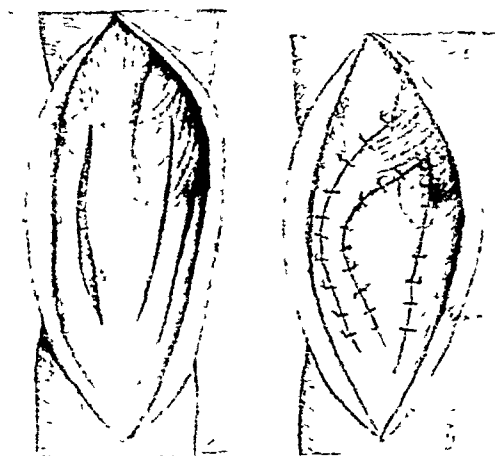


Fig. 1, B

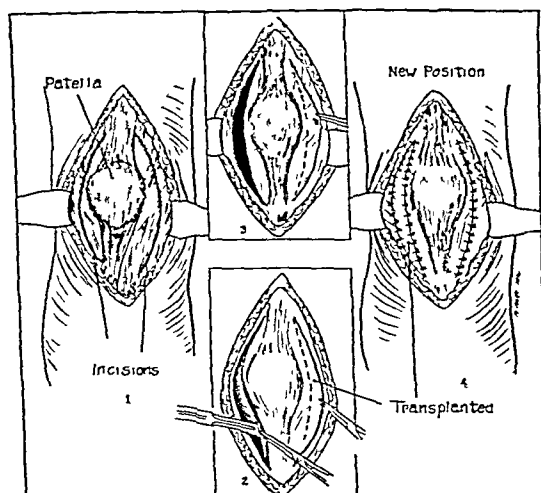


Fig. 1, C

the combined power of all the muscles that can be transplanted. The results are very uncertain. The procedure has been discarded because of the frequency of recurrences (Fig. 1, B).

The fourth group consists of fascial transplants. A strip of fascia lata or peroneal tendon was fastened to the patella and to the medial condyle of the femur (Gallie and LeMesurier). Others have used this operation with success (Ryerson) and still others recommend it for selected cases (Cole and Williamson). The fascial strip removed from the lateral side of the knee was run subcutaneously over the patella and fastened to the medial condyle (Klapp). This operation was also used by other authors (Karl and Hartleib). The

Fig. 1 A, Overlapping of fascia described by Murphy, Bevan and others (Typical of Group 1) B, Fascia and muscle transplant as carried out in the operation of Krogus modified by Gocht and others (Typical of Group 3) C, Fascial transplant. Operation of Dickson (Typical of Group 2) (A, from Murphy, Clin. John B. Murphy, B, from Krogus, Zentralbl. f. Chir.; C, from Dickson, Surg. Clin., North America)

iliotibial band was passed beneath the aponeurosis and sutured to the medial aspect of the tibia (Ober). A strip of fascia was used to encircle the patella and both ends fastened to the iliotibial tract and the medial condyle (Vorschuetz). A strip of fascia lata was run through a tunnel in the patella and fastened to the tibia to form a new patellar ligament (Soutter). Wilson used silk for a ligament. To correct the patella from above and hold it in alignment, the quadriceps tendon was fastened on to the gracilis muscle by means of a fascial ring (Rene Sommer). An Italian surgeon also did a reconstruction of the quadriceps tendon. Criticism of this method is that active forces, namely, the lateral pull of the quadriceps, continues to act against the ligamentous transplant which may, even if in relatively few cases, stretch or give way with resultant recurrence of the dislocation. Second, it does not correct the high position of the patella nor shorten the lengthened patellar ligament, therefore, it does not re-establish normal function of the quadriceps muscle.

The fifth group of operations comprises those upon the lower end of the femur. To prevent the patella from slipping laterally, an oblique osteotomy was performed which permitted a straightening of the leg and rotation into normal position (Graser, Huebscher). An osteotomy

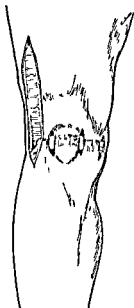


Fig 2 A

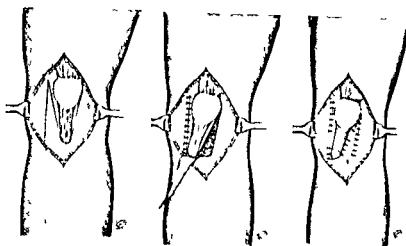


Fig 2, B



Fig 2 C

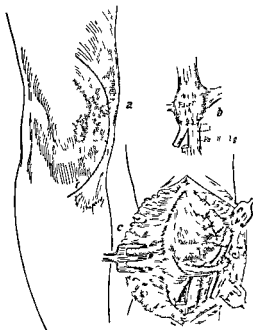


Fig 2 D

Fig 2 A Utilization of fascia lata for fixation operation of Klapp. Similar to operation of Ober and Soutter (Illustrative of Group 4) B Operation of Wagner. Transplant of the patellar ligament with fascial transplant (Group 5) C Fixation of patella by means of peroneal tendon (operation of Gallie) (Group 4) D Operation of Davis a modification of Goldthwaite's and similar to operation devised by MacAusland (A from Klapp *Chirurgische Operationslehre* B from Wagner *J Bone & Joint Surg* C from Gallie and Lemesurier *J Bone & Joint Surg* D from Davis *Surg Clin*)

from behind forward and from forward above was devised which lengthened the femur and put tension on the quadriceps (Hacker)

To prevent the patella from slipping laterally the external condyle was raised by means of an osteotomy (Sir Robert Jones). The external condyle was raised and an ivory peg inserted (Trendelenburg). Also the upper end of the

fibula was utilized (Boehler) and a wedge-shaped tibial graft has been employed (Albee—Fig 3, A). This last type of tibial graft has been combined with plication (Buzby). In extreme cases of genu valgum it may be necessary to carry out the correction by means of a supracondylar osteotomy. Attempts to prevent the slipping of the patella have not always been successful since the quadriceps pull remained laterally in spite of the correction (W. B. Owen). Furthermore, the quadriceps is shortened as a result of bone lengthening and this leads to limitation of flexion at the knee (Finsterer). The operation requires prolonged fixation and would, therefore, not be the operation of choice. With regard to the elevation of the external condyle, this is an ingenious device for those cases in which the slipping is due to the underdevelopment of the external condyle. It necessitates opening the joint. It would not effect a lowering of the patella and shortening of the patellar ligament, and thus would not re-establish the normal capacity of the quadriceps. Good results, however, have been reported with both methods (Drehmann, Schanz, Albee).

The sixth type of operation consists in transplanting the patellar ligament. The ligament was split in half, the outer portion drawn under the inner half and fastened through a drill hole in the median side of the tibia (Goldthwaite). Some refinement of this technique was made by MacAusland. The patellar ligament was freed from its insertion and transplanted to the inner condyle of the tibia by excising a triangular piece of periosteum. At the same time the vastus lateralis was divided because it was stronger than the vastus medialis. The fascia of the vastus medialis was reefed (Roux) which increased the tension on the quadriceps muscle. The inner third of the patellar ligament has been split and fastened medially and distally to the tibia under the periosteal bridge (Huebscher). The entire ligament has been transplanted medially (Bade and Parker) and at the same time drawn distally to a level lower than the ordinary insertion. A triangular transplant with its base at the insertion of the patellar ligament is swung from the medial side of the knee to the lateral side (Frank Forty). Camera transplanted the patellar ligament medially and at the same time did an osteotomy of the femur to correct the genu valgum. The patellar ligament has also been fastened by a wire nail (Sir Robert Jones). A block which included the attachment of the patellar ligament has been cut from the tibia and forced to slide medially, thus bringing about a medial transplant of the ligament (Kirschner). Plication of the medial

capsule has been done in connection with patellar ligament transplants (Davis). In the congenital type of dislocated patella with contractures in the lateral fascia and capsule, the procedures mentioned will not be adequate since they do not bring the quadriceps pull in direct line to the tibia. The quadriceps force continues to pull laterally and to act as an opposing force against the transplant. Furthermore, the patellar ligament runs at an angle from the patella to the tibial insertion. The force acting in this manner for a long period of time will tend to cause a rotation of the tibia which will result in a deformity of the leg.

Another original method of treatment to prevent dislocation of the patella has been to place a bone block taken from the patella itself in the external condyle of the femur (Estor and Estor). Costal grafts have also been used for this purpose (Rocher—Fig. 3, B).

Judging from the recent literature, the present tendency is toward some type of transplant operation. In one such operation there is a complete transplant of the quadriceps extension apparatus with incisions down into the joint. Then a transplant after the manner of Krogus is carried out with a medial shifting of the entire patellar insertion (Fevre and Dupuis, Voelcker, Dencks, Herlyn—Fig. 1, B). Another method is to make an incision along the patella on both sides, cutting down right through the joint. Then the patella and the medial side of patellar ligament are sutured so that the quadriceps tendon comes back into the midline. This leaves a gap on the lateral side which opens down into the joint. The patellar ligament is transplanted medially and fastened with a nail. The gap is allowed to remain open (H. Strube). In a similar manner the outer margin of the vastus externus and both sides of the patellar tendon were freed and a raw surface made on the inner side of the tibia. The muscle and tendon were displaced inward and sutured, and the surplus capsule was transferred from the inner to the outer side of the joint (Malkin). Another type of procedure is to dissect the patella and the patellar ligament and its insertion so that they are entirely free. Then a slit is made in the middle of the capsule of the knee joint through which the freed patella and patellar ligament are drawn. The opening in the capsule is closed with interrupted sutures. The bony attachment of the patellar ligament is then screwed on to the tibia, and the patellar ligament and patella are fastened to the original capsule of the ligament (Mouchet and Durand—Fig 3, C). The objections to these operations are first, that they necessitate exten-

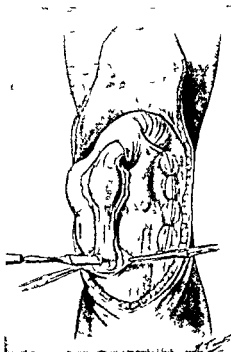
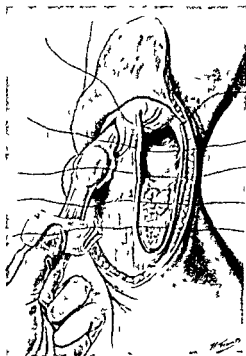
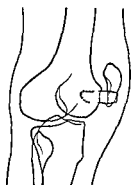
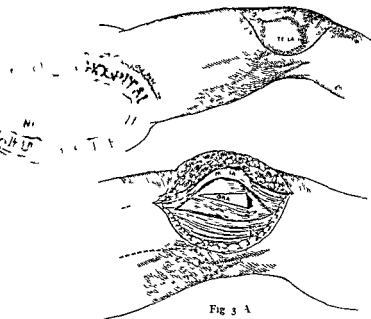


Fig 3 A Bone graft used to elevate the lateral condyle (Operation of Albee) B Bone graft inserted into the lateral condyle to prevent slipping patella (Operation of Estor) C Operation of Mouchet and Durand. Patella

entirely free transplanted through the knee joint and fixed with screw to tibia (A from Albee Med Record B from Estor and Estor Rev d'orthopédie C from Mouchet Albert and Durand Jacques J de Chir)

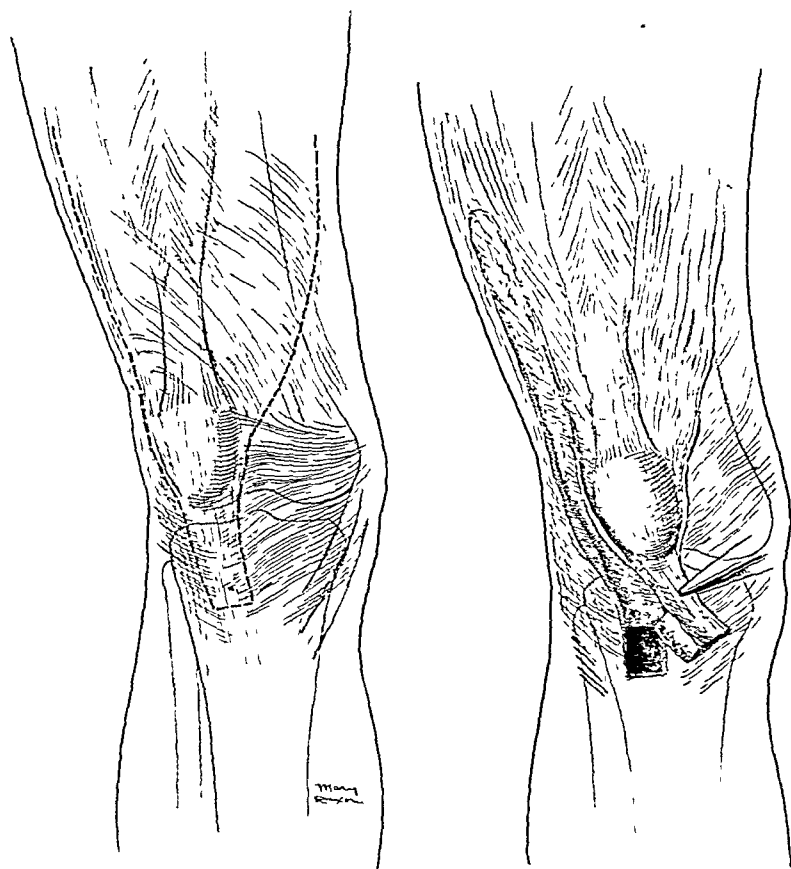


Fig 4 Total transplant operation (author's method) A, left, Shows position of the patella displaced laterally, the patella rides high and the lateral capsule is contracted. The attachment of the patellar ligament is lateral. B, Shows the incision of fascia down to the capsule. The incision extends well up alongside the vastus lateralis. Also shows the freeing of the patellar ligament and the removal of the bone block with attachment.

sive opening and suturing in the joint surface which increases the operative risk, second, they are complicated, third, the introduction of a metal screw or nail is not necessary, and finally, the position of the patella is not lowered so as to assume a normal position for leverage at the patella nor to restore normal muscle tension to the quadriceps muscle apparatus.

CRITERIA OF A SUCCESSFUL OPERATION

The criteria of a successful operation have been indicated in the above objections to previous operations. The prerequisites of an operation for correcting recurrent dislocation of the patella are: (1) the prevention of recurrence, (2) the feeling of absolute security on the part of the patient, (3) the

re-establishment of the full functional capacity of the knee joint, (4) the normal appearance of the knee, (5) the minimum risk to the patient, and (6) the short period of convalescence. Judged by these criteria, a review of the operative procedures that have been described up to the present time shows that no procedure devised so far has entirely fulfilled the requirements demanded by an operation that will assure both a satisfactory correction of the anatomical changes and restoration of normal function.

In order to meet the requirements of an anatomical correction for all types of recurrent dislocation, it is necessary to re-establish normal pull of the quadriceps muscle from its origin to its insertion. This includes the replacement of the

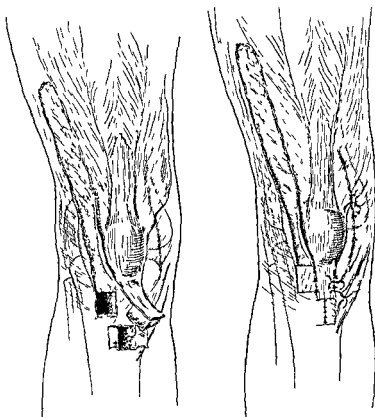


Fig 5 Total transplant operation (author's method) A left Shows the mobilization of the quadriceps apparatus and the removal of the corresponding block medially and distally to the original attachment of the patellar ligament on the tibia B Shows the graft countersunk The periosteum is sutured over the graft and the patellar ligament is sutured laterally with reefing of the medial fascia and capsule The quadriceps is in a straight line of pull and the patella is lowered

patella into its normal groove as well as the attachment of the patellar ligament to the patella so as to bring the line of pull directly through it to the ligament. The patella must be drawn down to its normal position with regard to its relationship to the knee. It is also important that the quadriceps tendon is not displaced but lies in the midline. Probably more important than any one of these factors is the fact that the upper margin of the patella must be brought over to the midline for it is here that the greatest force is exerted in weight bearing when the knee is flexed. Finally to re-establish normal capacity of the quadriceps muscle it is necessary to have normal tension, which means that, if patellar ligament is lengthened it is necessary to lower its insertion or somehow to shorten the mechanism of the quadriceps pull.

AUTHOR'S OPERATION

The operation about to be described was first performed 5 years ago and has been used in every case of recurrent dislocation that has come to my care since that time. Although the number is still small, the results have been uniformly successful. Four cases are reported in 2 of which there were bilateral congenital dislocations. The operation is applicable to the most difficult as well as to the simpler cases of the congenital and traumatic types. For the rachitic type with marked genu valgum the operation of choice undoubtedly is the correction of the genu valgum by means of a supracondylar osteotomy.

The technique of the operation referred to is as follows (Figs 4 and 5). A curved incision is made, starting above the upper lateral margin of the

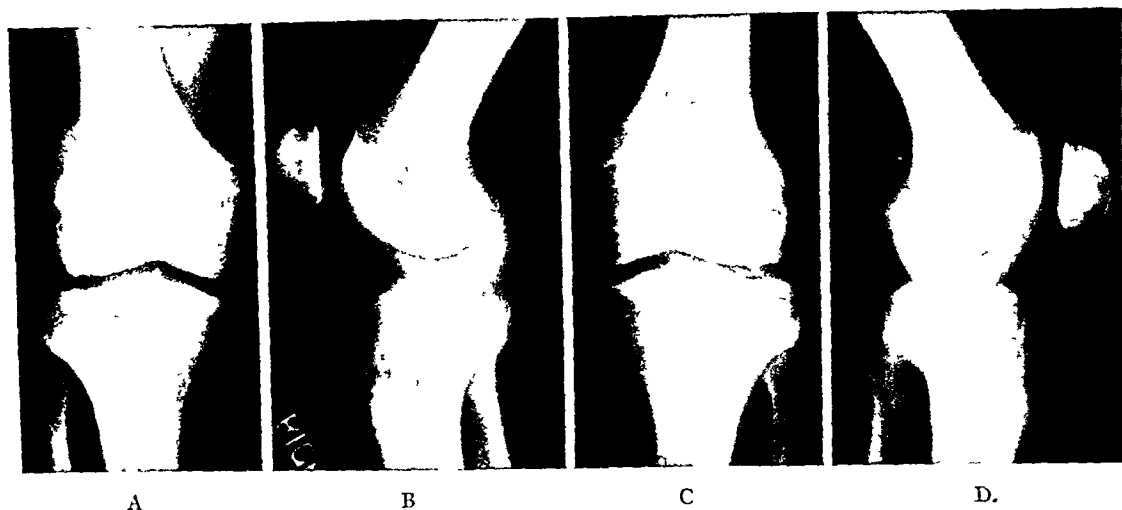


Fig 6 Case 1 G V A, Roentgenogram of right knee, anterior view, showing the patella laterally displaced and riding high B, Lateral view of the same knee. C, Roentgenogram of the same knee after operation. (Film reversed) Anteroposterior view shows patella more medial and lower D, Lateral view shows knee slightly bent and patella remaining low.

patella, curving laterally around the patella, and coming back to the midline about one-half inch below the tubercle of the tibia. The skin is freed on both sides to expose the patella, the conjoined tendon, and the patellar ligament. The patellar ligament is then dissected free down to its insertion. A block of bone about one-half inch square, including the attachment of the patellar ligament, is removed from the tibia by means of the electrical saw on three surfaces and an osteotome on the upper surface under the ligament. The entire lateral side of the patella is then dissected free by dividing the fascia down to the capsule. The dissection is carried along the lateral side of the conjoined tendon, well up into the area of the fascia lateral to the vastus muscle, this thickened fascia is divided down to the capsule but the operation remains extra-articular. The patella can now be drawn medially. The insertion of the patellar ligament is drawn to the median side of the tibia and distally until the patella lies low in the normal position between the condyles, this requires some tension of the quadriceps muscle. The periosteum is incised to make two flaps which are reflected. Then, a bony block one-half inch square is removed from the tibia in this area by means of the electrical saw. The attachment of the patellar ligament and its block are countersunk in this space, and the periosteum is then sutured over the block. The second graft is then fitted into the space at the tibial tubercle. Three sutures of No. 1 chromic catgut act as

further stays to hold the medial side of the patellar ligament to the periosteum. The stretched medial fascia is then reefed in the region of the upper margin of the patella. It is not necessary to transplant the fascia to fill in the gap on the lateral side. The skin is closed. The fixation is held by means of a plaster-of-Paris cast for from 10 to 14 days. The sutures are removed at the end of this period, after which the quadriceps muscle can be massaged and weight-bearing started, with the leg extended. The fourth week following operation the knee can be flexed and the quadriceps muscle allowed to contract voluntarily. Free flexion is permitted after 6 weeks.

A similar operation has been devised and executed by M. S. Henderson of the Mayo Clinic (personal communication), without emphasis on lowering the insertion of the patellar ligament.

The operation has proved satisfactory and apparently has the advantage of being a true reconstruction type of operation which permits early use and assures increased strength, as well as being applicable to both congenital and traumatic types of dislocation.

The principle of the operation fulfills all the requirements laid down as criteria for a successful operation in cases of slipping patella. It accomplishes full correction of the anatomical deformity, which includes the transplant of the quadriceps tendon, the patella, and the patellar ligament, so there is a direct line of pull in the quadriceps muscle system. It assures the proper position of

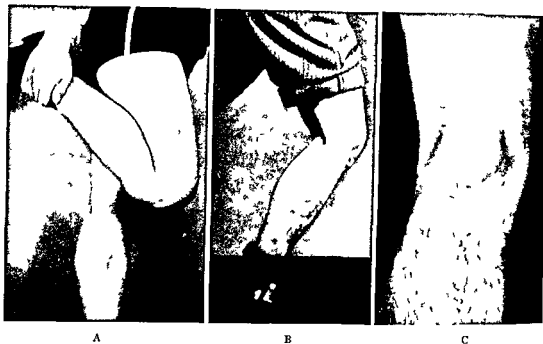


Fig 7. Case 1. A Photograph of right knee after operation. Patient has full flexion. B Photograph of patient showing right knee flexed and taking entire body weight. C Photograph showing normal appearance of the contour of the knee.

the patella both in regard to the condyles and in relation to the knee. Furthermore the upper margin of the patella is in the midline so the force acting there has no tendency to displace it laterally. The tension of the quadriceps muscle can be controlled so that the proper tension is permissible. The case histories of the patients operated upon will further establish that there have been no recurrences that the function has been returned to normal, that in some cases the capacity has been increased beyond that of the other knee and finally as volunteered by the patients, that the knees feel absolutely secure at all times.

CASE REPORTS

CASE 1. Congenital anomaly of the knee with osteochondritis dissecans possible and probably a loose body in the knee plus a slipping patella.

G V (Clinic No. 274669) 27 years of age was admitted to St. Luke's Hospital on July 15, 1931, complaining of a painful weak knee which would catch. Patient stated that ever since childhood he had had trouble with his right knee that something apparently would slip out of place in the knee and he would fall down. This occurred frequently and was followed by acute pain in the knee. During the last few years these attacks were associated with swelling in the knee. He had sought relief in many clinics throughout the country. He stated that in no instance was any surgery suggested that he was advised that

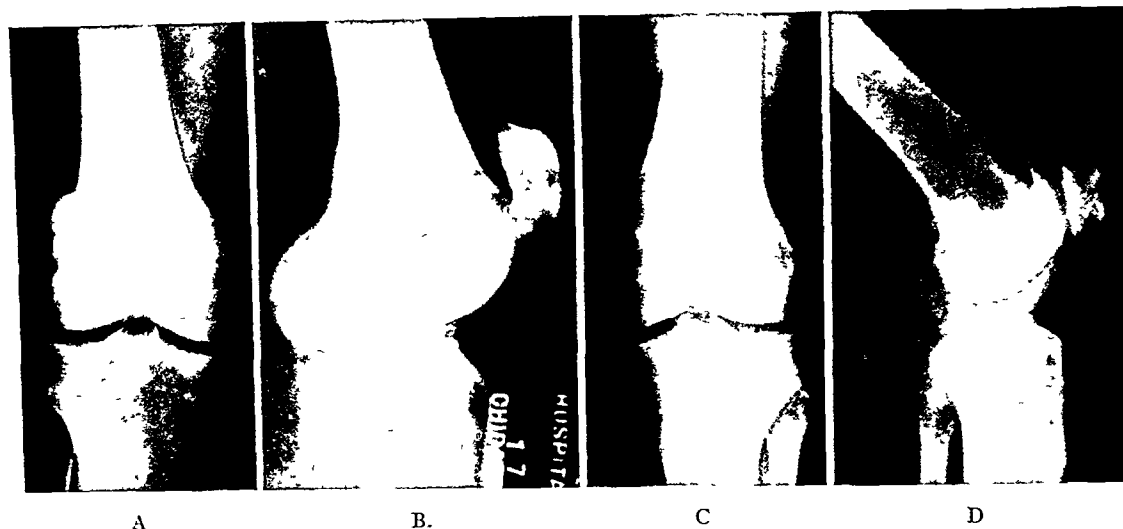
nothing could be done and that he would have to put up with his disability. During the 2 years preceding his admission to the hospital the attacks of a sharp catch in the knee had become more frequent and more severe and he had been unable to depend upon the knee with any degree of security. Past history included typhoid fever, scarlet fever, mumps, whooping cough and influenza, excision of a right cervical lymph node and tonsillectomy at the age of 14. His father died of angina pectoris; his mother was living and well; he had no brothers or sisters.

Physical examination showed a well-nourished white male, apparently comfortable, who was able to walk into the hospital. Pupils reacted normally; teeth were in good condition; tonsils cleanly removed. Neck was entirely negative save for a slight scar; lungs normal; abdomen negative. The patellar reflex was normal. Examination of the right lower extremity showed atrophy of the quadriceps with a slight decrease in the circumference of the thigh as compared with the left. The patella was movable in a wider range than normal and movement was associated with pain. A clicking could be felt over the knee when it was flexed and extended. Both patellae were smaller in circumference and thicker in diameter than one would normally expect.

Wassermann test was negative. Urinalysis was negative. Blood count showed 5,010,000 erythrocytes, 17,550 leucocytes and hemoglobin 20.2 grams. X-ray examination of the knee showed a defect on the posterior surface of the patella which suggested an osteochondritis dissecans.

The pre-operative diagnosis was congenital anomaly of the knee with osteochondritis dissecans possible and probably a loose body in the knee plus a slipping patella.

The following operation was performed:



A

B.

C

D

Fig 8 Case 2 E D A, Roentgenogram made before operation anteroposterior view. Patella is lateral and high. Lateral condyle is underdeveloped. B, Lateral view. Note that the patella is high and there is a large loose body between the patella and femur. C, Roentgenogram made after operation (film reversed) showing patella in center. D, Lateral view showing the patella lower and loose body absent.

A curved incision was made, starting above the upper lateral margin of the patella and curving laterally around the patella to come back in the midline about one-half inch below the tubercle of the tibia. The skin was freed on both sides to expose the patella, the conjoined tendon, and the ligament. The patella was found to be displaced laterally. The knee was then opened through an incision on the medial side, about an inch and one-half in length. The inner surface of the knee was examined for loose bodies, the posterior surface of the patella was examined and found to be roughened. The patella was everted to obtain a more satisfactory exposure. The posterior surface showed a demarcation which suggested an osteochondritis dissecans with a fragment loosened but still attached, the attachment was so firm that it resisted prying with a chisel and was, therefore, left intact. The knee was closed. The patellar ligament was then dissected free down to its insertion, the insertion of the ligament was freed by the removal of a block of bone about one-half inch square, which included the attachment of the ligament. The entire lateral side of the patella was dissected free by dividing the fascia down to the capsule. This dissection was carried upward along the lateral side of the conjoined tendon into the area of the fascia lateralis. The patella could then be easily drawn medially. The insertion of the patellar ligament was drawn to the medial side of the tibia, and distally until it was about $1\frac{1}{2}$ inches below its former insertion. At this point the periosteum was incised to make two perosteal flaps which were reflected. The bony block and the insertion of the patellar ligament were fastened so that both surfaces were in contact with raw bone. The perosteal flaps were sutured over the graft with No. 1 chromic catgut. Three stay sutures were used further to fasten the patellar ligament to the periosteum at a higher level. The medial fascia was then reefed in the upper margin of the patella by means of mattress sutures so that this area had the appearance of a ligamentous support. The skin was closed and a posterior splint of plaster-of-Paris was applied.

Post-operative course. On the second day the temperature rose to 101.6 degrees, it then subsided and ranged around 99 degrees until the eleventh day when it reached normal and remained so thereafter. For the first 3 days he required $\frac{1}{2}$ grain of codeine to relieve the pain; after that no opiates were necessary. On the sixteenth day he was able to walk. On August 7, 1931, he was permitted to return home. One week later he began to walk with the aid of a cane, and gradually began to flex the knee. He bore all his weight on the right limb. The quadriceps power was re-established before full flexion was permitted. He walked up and down stairs one step at a time until the sixth week after the operation. Eight weeks after operation he had full flexion of the knee and apparently normal power of the quadriceps.

The patient has been seen periodically for the past 5 years. At his last visit 3 months ago he had no trouble whatsoever with the knee. There is not the slightest grating, and he is able to run and jump without the least tendency toward any displacement or discomfort. He has absolute confidence that the knee will give him no further trouble in spite of the fact that he had always had a definite feeling of insecurity in regard to the knee from childhood to the time of operation. It is his opinion that the knee operated upon is definitely stronger than the other one.

This patient is an example of a severe congenital anomaly with a slipping patella and a progressive disturbance in function, as well as an increase in the anatomical changes. It is the type of case in which the condition could not conceivably be corrected by any of the previous methods described but it did respond to the procedure used in an entirely satisfactory manner not only from an anatomical but from a physiological standpoint as well.

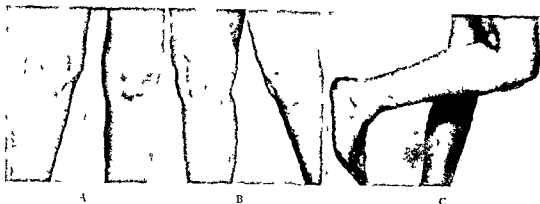


Fig. 9. Case 2. A Photograph taken after operation. Note that patella is more medial. B Photograph showing patient bearing full weight on leg operated upon with flexion of knee. C, Photograph showing range of flexion. Normal motion was present.

CASE 2 *Recurring dislocation of the patella of congenital origin with loose body in knee joint.*

E. D. (Clinic No. 13240) 27 years of age was admitted to Passavant Memorial Hospital on April 5, 1934, complaining of pain in the right knee the result of locking. Her disability had come on so insidiously that she was unable to set an exact date of her first trouble with the knee, but she had had a feeling of insecurity for the past 13 years. As nearly as she could remember she had had an attack of acute pain in the knee preceded by a locking at the age of 14 years. Six days previous to her entrance into the hospital while waiting upon a customer in a store she suddenly felt something slip in the knee, the knee became acutely painful and began to swell. She was first seen in the office where an x-ray examination revealed a loose body in the knee. Her history was otherwise essentially negative except for a previous pelvic operation (uterine suspension and appendectomy).

Urinalysis was negative. Blood count showed 4,450,000 erythrocytes, 11,940 and 13,300 leucocytes on two occasions, hemoglobin 10.15 grams. X-ray films showed hyper trophic changes in the knee with a large loose body. The bony spine was sharpened and the patella slightly displaced laterally; it appeared to be abnormal in shape.

Under general anesthesia the following operation was carried out:

A curved incision was made starting at the upper margin of the patella along its medial margin down to the tubercle of the tibia. The skin was freed and the patella was exposed; the patella was found to be displaced laterally. The knee was opened on the medial surface and a loose body the size of an almond was removed. Closure in layers was accomplished. The conjoint tendon and the patellar ligament were then exposed. An incision was made along the lateral side of the patella dividing the fascia down to the capsule; this incision was carried up along the side of the conjoint tendon and into the lateral fascia of the vastus muscle. The patella was freed so that it could be drawn easily medially. Then the patella was dissected free and a bony block one half inch square was removed by means of an electrical saw from the tibia in the area of its insertion. The patellar ligament was incised medially about 1 1/2 inches distal to this area. Flaps were thrown back and a bony block about 3/8 inch square was removed. The attachment of the patellar ligament and its block were countersunk in this place. The periosteum was then

sutured over the block. The second graft was fitted into the space of the tibial tubercle. The periosteum was sutured over the graft and re-enforcement sutures were made from the patellar ligament directly to the periosteum of the tibia. The medial fascia was reinforced by reeling at the upper margin of the patella. The skin was closed and a plaster of Paris posterior splint was applied.

Postoperative course. The temperature rose to 100.4 degrees on the tenth day; it was normal and remained so. Sutures were removed on the twelfth day. Recovery was entirely uneventful. The patient was dismissed from the hospital on May 17, 1934. She returned to work in a clothing store on August 1, and was on her feet for 5 hours every day.

She was last seen a month ago. She has had no trouble whatsoever with the knee. She states that the knee operated upon is definitely stronger than the other and that she no longer has any feeling of insecurity, much less any slipping or locking. She has worked continuously. She has noted definite improvement in the appearance of the knee; it is straighter and has what she describes as a more normal appearance. The patella lies in a new position.

This case is an example of a knee that had a true loose body which gave rise to symptoms of which the patient complained at the time of examination. The loose body may or may not have been secondary to her primary condition, which was a congenital type of recurring dislocation of the patella. The anatomical changes consistent with such a diagnosis were very typical in this case. The correction by means of the operation described resulted in complete recovery from all symptoms which dated back to the earliest memories of the patient.

CASE 3 *Traumatic arthritis of the left knee; fracture of the internal semilunar cartilage; slipping patella of the congenital type; genu valgum.*

J. W. DEY (Clinic No. 1059) 20 years of age came for consultation on November 14, 1935, complaining of injury to the right knee. The duration of the trouble was fifteen

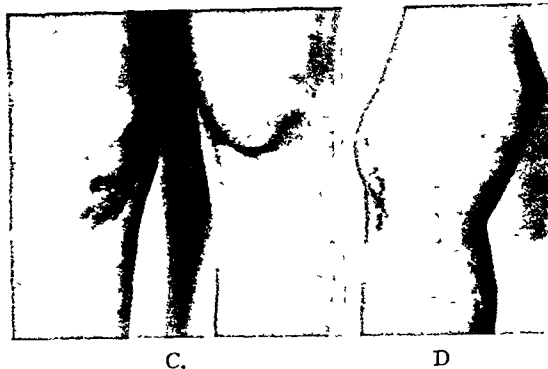
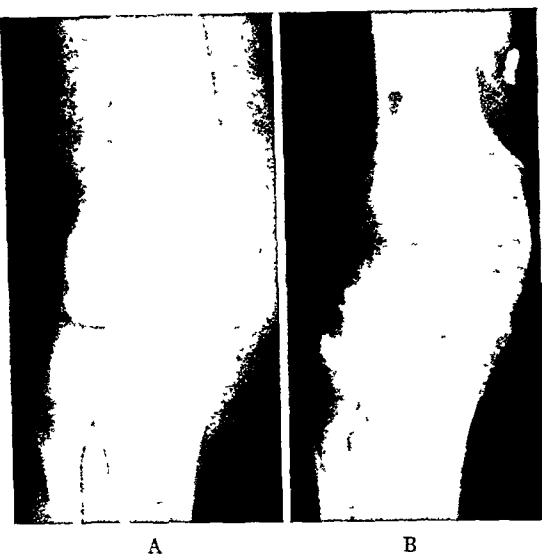


Fig 10 Case 3 J W DeV A, Roentgenogram made before operation, showing the loss of joint space and marked swelling of the synovial tissue B, Roentgenogram made after operation The alignment has improved and the swelling of the synovial tissue has disappeared C, D, Photographs showing appearance of the knee after operation

years When she was about 15 years of age, something slipped in her knee while she was walking and she fell The knee was painful and she was in bed 6 weeks Periodically from that time on the knee would suddenly slip out and cause sharp pain Five years previous to examination she stepped off the curb and the knee slipped, causing excruciating pain over the inner side of the knee She was on crutches for several weeks The knee has troubled her ever since and for the past 2 years the pain has been constant She had consulted many physicians and gone to various osteopaths No relief was obtained Casts had been applied with only temporary benefit During this period motion in the knee was practically lost and the knee was constantly swollen Arthrodesis of the knee was advised repeatedly At times the opinion was expressed that it was a tuberculous process, while again no diagnosis was made but still fusion was recommended

At the time of examination there was a marked genu valgum, the knee was so swollen that it was impossible to palpate the patella Motion was painful and the patient was unable to walk without extreme limping and the use of crutches There was some local heat present and tenderness was elicited over the inner side of the knee The x-ray film showed a loss of joint space with signs of arthritis

A diagnosis was made of (1) traumatic arthritis of the left knee, (2) fracture of the internal semilunar cartilage, (3) a slipping patella of the congenital type, and (4) genu valgum

In view of the severe arthritis, a fusion of the knee was justified, but inasmuch as the changes were secondary to a neglected slipping patella with internal derangement of the knee, the patient's desire to avoid the loss of motion at the knee was given consideration, and reconstruction of the knee was agreed upon

The operation was done after the technique described in this thesis It included opening the knee joint to expose the joint surfaces The internal semilunar cartilage was entirely absent There was a membranous tissue over the cartilaginous surface of the tibia The remnants of the semilunar cartilage and its attachment, as well as the membrane were dissected out with a sharp scalpel and

removed The joint surface was then found to be eroded in spots The cartilage was thinner than normal There was an overgrowth of the margin, osteophytic in character, which was removed with a sharp chisel The joint was closed and the technique for repair of the dislocated patella was executed

Postoperative course. The knee showed great swelling on the third day The compression bandage was released and a suture was removed to permit drainage of serosanguineous fluid The swelling gradually subsided and the wound closed In 3 weeks the patient was allowed to go home Eight weeks after operation the motion was limited, and an attempt to gain motion by manipulation under anesthesia was executed An osteoclasis took place at the supracondylar line and the genu valgum was corrected The cast was worn for 5 weeks

When seen 3 months later she walked without the aid of crutches and had no pain The genu valgum had decreased There were only about 10 degrees of motion present, but this was entirely free and painless Motion beyond this point would cause some pain The patient stated, however, that she was slowly gaining more motion in the knee

This case illustrates the damage caused by neglecting a slipping patella over a period of years The recurrent dislocation of the patella in early childhood caused an internal derangement of the knee with probably a fracture of the semilunar cartilage After a period of over 15 years a high degree of arthritis developed A fusion operation seemed indicated and would have been justified In accordance with the patient's request, however, an attempt to correct the condition by means of a total tendon transplant operation was carried out, with a result very satisfactory to her

CASE 4. Traumatic type of slipping patella

I S (Clinic No 12626), 29 years of age, was admitted to Passavant Memorial Hospital on December 26, 1932, complaining of a dislocation of the right knee cap which

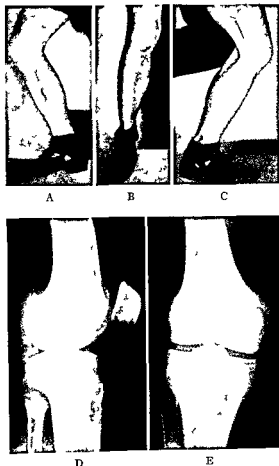


FIG. 11. Case 4. I S. A Photograph taken after operation. The knee is able to take full weight bearing with flexion. B Photograph showing the normal appearance of the knee. C Another view. D Roentgenogram made after operation showing patella riding low and in a relatively medial position. The dense shadow in the tibia shows the position of the bone graft with attachment of patellar ligament. E, Another view.

gave rise to pain, occasionally severe, and extreme weakness of the right knee. He stated that 8 years before while playing football he made a quick movement with his right leg and felt a severe acute pain in his right knee. He noticed that the patella was dislocated. He was unable to walk without pain and there was swelling which lasted about 2 weeks. The patella seemed to return to normal position. From that time on, however, whenever he bent his knee the patella would dislocate and at four different times he had severe pain with what seemed like a true dislocation of the knee cap and associated swelling. Past history included measles, mumps and chicken pox and catarrhal jaundice at 14 years of age, otherwise he had always been well.

Physical examination was negative except for the right lower extremity. The right patella was normal in size

and contour. The knee was apparently normal when extended but when flexed there was a prompt dislocation of the patella toward the outside which was not reducible. It was possible to reduce the patella only when the knee was extended. The dislocation occurred each time the knee was flexed. There was definite atrophy of the quadriceps muscle.

Urinalysis was negative. Blood count showed 5,150,000 erythrocytes, 7,500 leucocytes, hemoglobin 16.07 grams.

On December 27, 1932, the following operation was performed:

The patella was exposed through a lateral incision 6 inches long. The fascia on the outer surface of the vastus lateralis was divided as were the ligament and fascia lateral to the patella. These structures were about 1 1/2 inches thick in this area and were firmly contracted. The dissection was carried out until the patella could easily be displaced medially. With the knee flexed, the insertion of the patella was transplanted from its position on the lateral side of the tibia to a point 1 inch medial and 1 inch distal to its former position by means of a bone graft. The new attachment was reinforced with chrome sutures from the patellar ligament to the periosteum. The medial ligament was shortened at the upper margin of the patella. The wound was closed and a plaster of Paris cast was applied.

Postoperative course. The temperature rose to 99.8 degrees after the operation but subsided to normal on the fourth day and remained normal thereafter. Convalescence was entirely uneventful. The patient had practically no pain. The stitches were removed and weight bearing started on the tenth day. The patient walked with the aid of crutches. Motion was started and on the eighteenth day flexion of the knee was permitted. He was dismissed from the hospital on January 14, 1933. Two weeks later he was carrying out his occupation of teaching manual training. The knee gave no pain and its strength increased until its capacity was definitely greater than that of the other knee. He hunted and walked great distances in the fields without becoming tired in the lumbered operated upon. He has had no pain since the operation.

When last seen in December, 1935, he had been playing basketball without the slightest feeling of insecurity concerning his knee. Previous to operation he was unable to drive a car. Since that time he has not only been driving a car but has also taken up aviation. He has never had any concern about a recurrence nor any feeling of insecurity.

This is an excellent example of a recurrent dislocation which had become actually a chronic dislocation. It exemplifies also a true traumatic type of slipping patella. The operation described proved satisfactory in every way and it is difficult to conceive of any other type of operation which would be suitable for the anatomical changes that were present in this case.

SUMMARY AND CONCLUSIONS

1. A classification has been evolved and described on a clinical basis, dividing recurrent dislocations of the patella into three types: (1) congenital, (2) traumatic and (3) rachitic. A description of the anatomical changes in each group is given. The effect of the morbid anatomy is expressed in terms of altered function. The

importance of re-establishment of normal function is emphasized.

2 A review of all the previous operative methods of correction is reported, classifying them into six groups according to the method of attack. This includes a complete review of the literature with bibliography. A critical analysis of each type is made on the basis of criteria set up for a satisfactory operation.

3 An operation is described which is original in that it fulfills all the prerequisites of satisfactory correction, namely: (1) it prevents recurrence of the dislocation (2) it gives the patient a feeling of absolute security, (3) it re-establishes the functional capacity, (4) it gives the knee a normal appearance, (5) the risk to the patient is minimum; and (6) the convalescence is short.

4 The technique of the operation is described in detail, the rationale for each step of the operation is substantiated.

5 Illustrative cases are reported. The method has been in use over a period of 5 years, and the results have been uniformly satisfactory.

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SEGMENTAL ENTERITIS

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THE subject of so called regional or, as I prefer to call it, segmental enteritis, is being widely discussed at present. A large number of papers on this subject have appeared in the last 4 years. Opinions differ not only as to the pathogenesis of these interesting lesions but also as to the best method of surgical treatment.

Undoubtedly a few years will elapse until we arrive at fairly definite views concerning the etiology of this disease and the best form of treatment for these lesions.

CLASSIFICATION

While inflammatory tumors of the intestinal tract have been reported for many years, Crohn, Ginzburg, and Oppenheimer (6) first classified these interesting lesions in 1932. Furthermore, they clearly described for the first time the chronic perforations with fistulous communications to other parts of the intestine, that occur mainly in various parts of the colon. Originally they thought that this disease occurred only in the distal 2 or 3 feet of the ileum. For this reason they called it "terminal ileitis." Later observations showed that more proximal parts of the ileum may

be involved. Therefore Crohn adopted the name suggested by Bargen, "regional ileitis."

In 1933 Harris, Bell, and Brunn (9) reported a case in which not only the ileum, but parts of the jejunum were involved. Soon after their publication Crohn (5) stated that he had observed similar cases. He then adopted the name suggested by Brown, "regional enteritis" (7).

Thus in the short period of 2 years it was demonstrated that this inflammatory disease may develop in any part of the small intestine (either jejunum or ileum) and the original name of terminal ileitis had to be changed first to regional ileitis and later to regional enteritis. However, this classification did not completely suffice. A number of those interested in this subject felt that the process was not necessarily confined to the small intestine but might extend (and frequently did extend) into the colon. Colp, in reporting a case of this nature, states: "This case seems to substantiate the belief which many have expressed that regional ileitis is a phase of a chronic inflammatory disease of unknown origin which does not only elect and affect the ileum, but may attack the cecum and other areas of the colon." Evidently this simultaneous involvement of the

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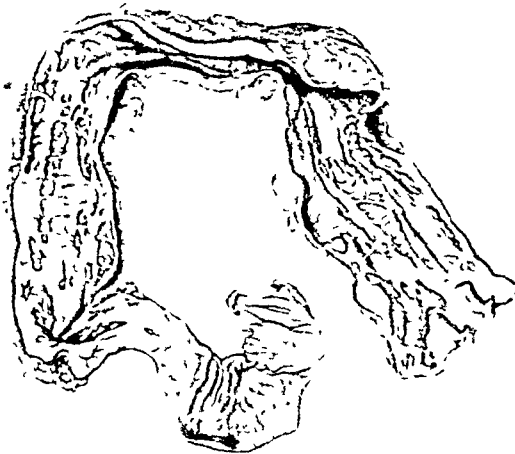


Fig 1. Autopsy specimen of severe ulcerative colitis with retrograde extension into the ileum (From Crohn, 7).

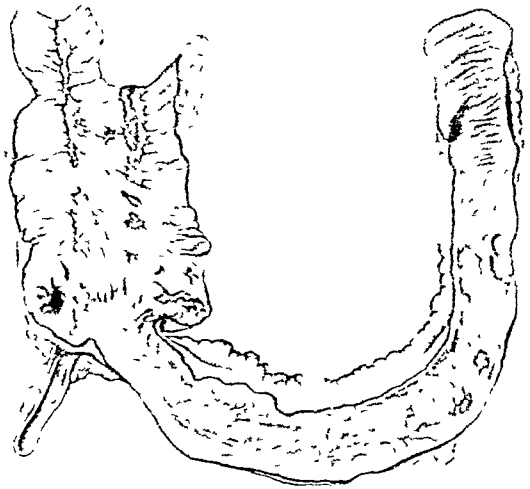


Fig 2 Case 2, T W. Resected specimen of segmental ileocolitis

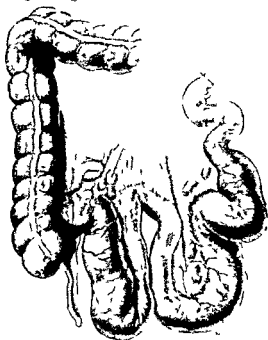


Fig 3 Case 10 G F Resection in 2 stages Primary operation Subacute ileitis with very large mesenteric glands Ileotransverse colostomy



Fig 5 Case 10 G F Barium enema showing extensive ileitis above the ileocolostomy

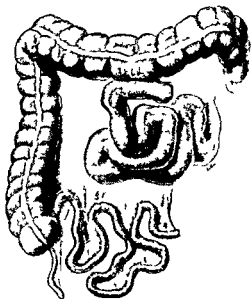


Fig 4 Case 10 G F Resection in 2 stages Secondary operation Healed ileitis Resection of distal ileum cecum and part of ascending colon

ileum, cecum and colon is not at all infrequent for Brown (2) reported 5 such cases among 18 cases of regional enteritis. In 1936 Crohn (7) reported 9 cases of combined ileitis and colitis. He says "This relationship is usually not sequential

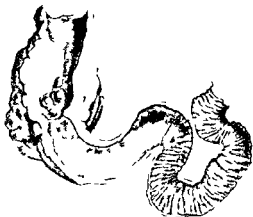


Fig 6 Case 11 D D Resection in 2 stages Specimen of distal ileum cecum and part of ascending colon Healed ileitis

but synchronous. Occasionally, however, it would appear as if a primary ileitis had spread to and involved the colon in a secondary invasion."

It is today a moot question whether the process spreads from the ileum into the colon (Crohn and others) or whether the primary seat in the combined form is in the colon with secondary extension into the ileum (Berg). As long as the cause of this disease is unknown, these opinions are mostly of a speculative nature.

It is evident from this survey that the original conception of Crohn, Ginzburg, and Oppenheimer that this interesting lesion occurs only in the most distal part of the ileum was not correct. Undoubtedly, inflammatory tumors of the intestines occur more frequently in the terminal part of the ileum than in other parts of the intestinal tract. However, they may be and have been observed in any part of the jejunum, ileum, or colon. In fact, similar lesions have been observed in the stomach.

It is interesting to speculate about the cause of the frequency of these lesions in the ileum just proximal to the ileocecal valve. This valve represents the only barrier between the pylorus and the anus. Whether the temporary stagnation of intestinal contents in this region favors the frequency of these inflammatory tumors in the most distal part of the ileum is at present purely problematical.

I doubt whether segmental enteritis represents a clinical entity. As our views on ileitis and ileocolitis stabilize with accumulated experience during the next few years, this lesion may turn out simply to represent a milder form of ulcerative colitis. Many of the cases have a very acute onset with fever, diarrhea, and with mucus and blood in the stools. The cases may belong to a group, in which segmental enteritis represents a lesion caused by a less virulent virus of the same nature which in its more toxic state produces the well known clinical picture of an ulcerative colitis.

Certainly if we compare the picture which Crohn (7) presents of a severe ulcerative colitis (Fig. 1) with the picture of a case of ileocolitis in which I operated upon the patient (Fig. 2), we notice identical lesions in the ascending colon. Both pictures were drawn by the same artist, one from a postmortem specimen, the other from a specimen obtained at operation.

Formerly we considered acute ulcerative colitis as a lesion which always affected the whole colon. In 1930 Bargen and Weber reported a series of cases in which only certain parts of the colon (mainly the transverse or descending colon) were involved in the pathological process. They pointed out the segmental nature of these lesions affecting

parts of the colon, whereas the rest of the large intestine was perfectly normal. These cases represent milder forms of acute ulcerative colitis, whereas the more virulent variety affects the whole colon.

In the same manner ileitis in its most toxic form may affect the whole ileum. Crohn has reported a case in which not only the whole ileum, but the lower part of the jejunum, was involved. Such extensive lesions of the small intestine seem to be extremely rare. However, simultaneous involvement of different segments of the ileum are by no means infrequent. For instance I have noticed in a number of cases that the most distal part of ileum was involved in the lesion. One or 2 feet of ileum above the lesion were perfectly normal. As we inspected the gut farther up, we found another 1 to 2 feet of ileum involved in the same process which was found at the ileocecal valve.

I think the name of *segmental enteritis* indicates very well that in the vast majority of cases this disease is confined to certain well localized segments of the intestinal tract. This general group consists of the following subgroups (in order of their frequency): (1) segmental ileitis; (2) segmental colitis; (3) segmental ileocolitis; (4) segmental jejunitis; (5) segmental jejuno-ileitis.

A very valuable paper has been presented by Erb and Farmer. They reported 4 cases of acute ileocolitis in children and pointed out that the very acute processes which they found mainly in the distal ileum may represent the acute stages of the disease which in its chronic form Crohn and his co-workers have described as regional ileitis. After all, a large number of patients suffering from segmental or regional ileitis or ileocolitis have passed through an acute stage long before they are admitted to the hospital.

Two cases of successful resection for very acute ileitis with gangrene were reported by Jackman. On account of the severity of the symptoms they required immediate operation. With less severe symptoms they might have subsided spontaneously and at a later date presented the familiar picture of a subacute or chronic segmental ileitis.

CLINICAL PICTURE

I shall refrain from discussing in detail the clinical picture of these interesting lesions, as Crohn and his co-workers have given an excellent and minute description of the different phases of the disease in their first publication. I could not add much to the subject. Furthermore Meyer and Rosi and Koster and his associates have covered the same ground. Suffice it to say that the symp-

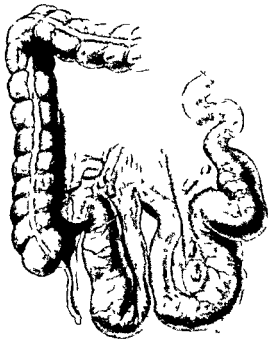


Fig 3 Case 10 G F Resection in 2 stages Primary operation Subacute ileitis with very large mesenteric glands Ileotransverse colostomy



Fig 5 Case 10 G F Barium enema showing extensive ileitis above the ileocolostomy

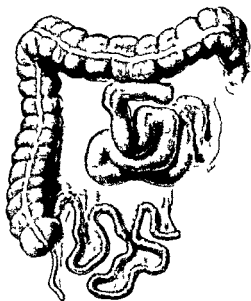


Fig 4 Case 10 G F Resection in 2 stages Secondary operation Healed ileitis Resection of distal ileum cecum and part of ascending colon

ileum cecum and colon L. not at all infrequent for Brown (2) reported 5 such cases among 18 cases of regional enteritis. In 1936 Crohn (7) reported 9 cases of combined ileitis and colitis. He says "This relationship is usually not sequential

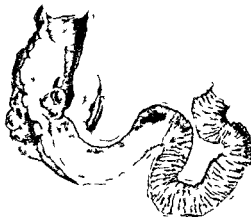


Fig 6 Case 11 D D Resection in 2 stages Specimen of distal ileum cecum and part of ascending colon Healed ileitis

of the gut in the first free area above the lesion I have noticed in a number of cases that a free area of normal intestine about 1 foot in length existed between two diseased segments. It is clear that unless sidetracking is effected above the lesion, a cure cannot be expected.

Cases 10 and 11 are of sufficient interest to warrant a more detailed description.

CASE 10. G. F. When this patient was operated upon the first time (December, 1935) she presented the typical picture of an ileitis just above the ileocecal valve. The colon was normal. The distal ileum showed an extensive lesion reaching about 3 feet proximally from the ileocecal valve. The first foot proximal to the cecum was markedly involved. Proximal to this lesion there was about 1 foot of gut which seemed to be apparently free from disease and then again we encountered another foot of diseased ileum. The intestine was markedly injected, its wall very much thickened. There was extensive involvement of the mesenteric glands in this area, some of the glands being the size of large grapes (Fig. 3).

In view of this extensive lesion it was deemed advisable to perform an ileotransverse colostomy and to postpone possible resection to a later date.

The patient was observed in the follow-up clinic. After a few months of apparent cure the diarrhea recurred, accompanied by pain in the lower abdomen. It was assumed that the sidetracked distal ileum was still diseased. Removal seemed advisable in order to safeguard the patient against extension of the process into the colon.

At the second operation (June, 1936) the lesion presented an entirely different picture from the lesion encountered at the previous operation. At this time the diseased part presented a small narrowed tube without apparent signs of inflammation. The glands described previously were neither visible nor palpable. We were evidently dealing with a healed ileitis (Fig. 4). Cecum, appendix, and colon were normal. The anastomosis was soft and patent. The excluded part of the distal ileum (2½ feet) was removed with the appendix, cecum, and about 2 inches of the ascending colon.

Pathological report (Doctor Klemperer). The ileum gives the appearance of diffuse atrophy. Its lumen is narrower than normal and it measures 2¾ centimeters in width when opened. In one portion (about 23 centimeters from the ileocecal junction), the width of the small bowel is only 1¾ centimeters. This narrower section extends for a distance of 8 centimeters. The wall of the ileum does not appear to be indurated or thickened. The mucosal surface appears clean and in some areas gives the impression of atrophy. The cecum and resected part of the ascending colon appear normal.

Microscopical report. The mucosa of the terminal ileum is conspicuously narrowed. The glands are widely separated and shortened. The epithelium of the glands consists of cylindrical cells, frequent goblet cells, and Paneth cells. The stratum proprium shows a moderate infiltration of eosinophil polynuclear leucocytes and is chiefly made up of fibroblasts. The submucosa is slightly thicker than normal, made up of connective and fat tissue with areas of fibrosis and contains several lymph follicles. The muscular coat is without changes. The subserosal layer is thickened and shows numerous nodular infiltrations of lymphocytes with sporadic giant cells of the foreign body type.¹

¹This patient was re-admitted in May, 1937. She had been perfectly well up to 3 months ago. Barium enema (Fig. 5) showed an extensive lesion in ileum just above ileocolostomy. Reoperation (July, 1937) showed involvement of about 3 feet of ileum at anastomosis. Resection, cure.

CASE 11. D. D. This patient was first admitted to the gynecological service of the Mount Sinai Hospital in July, 1936, with a 6 weeks' complaint of postprandial lower abdominal pain and vulvar swelling. There was a history of chorea at the age of 5 with 5 annual recurrences thereafter, but no history of cardiac embarrassment. Examination at that time revealed a moderate degree of left cardiac enlargement, a presystolic crescendo murmur, snapping first apical sound, and a soft diastolic apical murmur. A round resistant mass was palpable in the right lower quadrant. On vaginal examination the uterus was found to be normal, but to its right was found a cystic mass. Occupying a semi-circular area to the left of the anus was a reddened nontender, edematous, coxcomb like excrescence made up of three distinct lobules. The right labium majus was twice the size of the left and appeared edematous. The Frei and blood Wassermann reactions were negative. Abdominal exploration disclosed a right dermoid cyst which was resected with the right ovary. The terminal 4 inches of ileum, the cecum, and appendix were found enlarged, their walls thickened and hemorrhagically discolored. A few discrete lymph nodes were found in the adjacent mesentery, one of which was excised for microscopic study and proved to be the seat of a non-specific hyperplasia.

The patient was then transferred to the medical service for further study. A barium enema revealed a stenosing lesion of the terminal 6 inches of ileum and a marked irregular stenosis of the caput coli suggestive of regional ileitis. Agglutination for dysentery was negative. A Rehfuess test meal showed free acid up to 20. A second exploratory laparotomy was then performed on the surgical service. The terminal 6 inches of ileum presented an inflammatory lesion. Two points, one 3 inches from the ileocecal angle and the other approximately 6 inches from the angle, were more extensively involved. Here the induration, redness and narrowing were most severe. The cecum was adherent to the abdominal scar and omentum and therefore could not be visualized. An ileosigmoidostomy with exclusion of the inflamed portion of the intestinal tract was performed. Except for the development of a pneumonic process over the left chest posteriorly, the postoperative course was uneventful and the patient was discharged to the outpatient department on the fourteenth postoperative day, 40 days after admission.

Second admission. The patient was readmitted December 16, 1936, approximately 4 months after her last operation with a history of occasional right-sided abdominal pain, a tender mass in the right lower quadrant, and a recent increase in number of stools.

The additional pertinent physical findings were an irregular, slightly tender mass within the right lower quadrant, enlargement of the right labium majus and a firm perianal mass 1.5 by 0.75 inches. The heart presented the evidence of a chronic valvular lesion described on the first admission. It was feared that in the presence of diarrhea the inflammatory process might extend along the large bowel.

Operation consisted of resection of the distal ileum, cecum, and ascending colon, with closure of fistulous communications between the ileum and transverse colon and between a high loop of ileum and a portion of the non-functioning ileum. Several hours after this operation the patient's respirations increased to 32 per minute and numerous fine basal râles were heard. On the morning following operation, the respiratory rate had risen to 40 per minute. A moderate degree of cyanosis of the lips and nail beds also appeared. A roentgenogram of the chest showed evidence of an extensive bronchopneumonia. The patient's condition rapidly grew worse, her cyanosis increased in intensity, the pulse mounted to 150-170 and became very poor in quality. Her temperature rose to 103.4 degrees, death

toms of fever, diarrhea with mucus and blood in the stool loss of weight and anemia are very similar—though all in an attenuated form—to those which we encounter in acute ulcerative colitis. On the other hand, segmental enteritis presents two outstanding symptoms which we are not apt to find in ulcerative colitis, namely (1) fistulous communications between the lesion and other parts of the intestinal tract, and (2) symptoms of incomplete intestinal obstruction.

However, I would like to point out that perianal fistulas and rectovaginal fistulas are associated occasionally with this disease. They may occur in cases in which the main lesion is confined to the small intestine and in which the colon is absolutely free from disease. It is interesting to point out that in the same way as there may be a connection between terminal ileitis and the ileocecal valve (see above), the anal barrier may favor localization of the virus in this region with *secondary fistula formation*. These fistulas may give an important clue toward establishing the correct diagnosis. For this reason they deserve more attention and more minute consideration than they have received in previous publications on this subject. Three among our 11 cases had inflammatory processes in the anal region, one had multiple fistulas in ano, one had a recto vaginal fistula, one a virgo had condylomas.

This disease seems for the most part to affect persons in the second and third decades. However, cases have been reported, in which the disease occurred in infancy. For instance, Rockey and Meyer have reported cases in children 5 and 9 years old. Among our 12 cases only 3 patients were above 21 years old.

There seems to be no predilection for one sex as compared to the other. Koster states that among 62 cases reported in the literature 33 were males and 29 females. In our material of 12 cases 5 were males and 7 were females.

Crohn (5) has reported the cases of a brother and a sister who had this disease and suggested the name of 'familial ileitis'. He states 'The occurrence may be purely accidental or it may have significance as to a congenital predisposition or a transmissible causative agent in this disease'. In our material, Cases 7 and 9 were sisters, one married, the other unmarried. They had not lived in the same house for many years. I think the occurrence of ileitis among members of same family is, as in many diseases, purely accidental.

SURGICAL TECHNIQUE

Segmental enteritis is a distinctly surgical disease. There are two methods for dealing with

this condition (1) resection in one or two stages (2) sidetracking (ileocolostomy with division of the ileum above the lesion). Before we discuss the comparative values of these procedures I would like to mention that apparent cures have been reported after simple exploration or not more than an appendectomy (Meyer, 3 cases Koster 7 cases). However, the observation time in these cases extended over a few months only. One case only was followed for more than 1 year, and none of the cases for 2 years. It is very probable that these improvements are due to remissions in the disease rather than cures. Crohn has reported a case which 2 years after simple exploration and a gain of 50 pounds required resection due to incomplete intestinal obstruction. Meyer reports a case which 3 weeks after exploration required resection on account of progressive symptoms.

While we can thus dismiss with a few words simple exploration as a non curative and unsurgical procedure we are not prepared at present to state that resection either in one or two stages must be performed in every case in order to effect a cure. We have tried on my service not to be too arbitrary about resection as we have seen cures following simple sidetracking. Sidetracking means a complete division of the small intestine above the lesion closing of both cut ends by a three layer suture to be followed by a lateral anastomosis between the ileum and transverse or descending colon. A lateral anastomosis without division of the intestine is a useless operation as the affected part of the bowel is not put at rest.

It is not the object of this paper to give a detailed description of the operative technique employed in our 12 cases (see Table I). Three patients were subjected to primary resection 4 were resected in two stages whereas in the 5 remaining cases shortcircuiting was done.

One patient (Case 11) died within 24 hours after the operation of an acute rheumatic endocarditis.

With one exception (Case 7) division of the ileum above the lesion with ileocolostomy seems to have effected a complete cure in our series, whenever this simple procedure was employed. In 1 case (Case 4) multiple external fistulas healed completely following this procedure. In another patient (Case 5) an enormous mass (size of a grapefruit) began to shrink in size immediately after the operation and had practically disappeared when the patient left the hospital 3 weeks after the operation.

However as I have pointed out, the segmental character of this lesion must be kept in mind by the surgeon. It is not safe to make the division

ulcerated areas were also found toward the tip. The heart was moderately enlarged for the size of the individual and weighed 240 grams. There was evidence of a chronic rheumatic interstitial valvulitis of the mitral and aortic valves with a recently superimposed verrucous endocarditis of the mitral and tricuspid valves. The lungs were markedly edematous and congested. There were also chronic passive congestion of the spleen and kidneys, a moderate amount of fluid in the peritoneal cavity, a few focal mucosal ulcerations of the transverse colon and the peri-anal inflammatory zones as described clinically.

Cause of death: acute rheumatic valvular disease.
The specimen showed a healed ileitis.

This patient in spite of her heart lesion had stood two previous laparotomies very well. Pulse and temperature were normal. There were no clinical symptoms indicating an acute exacerbation of the chronic rheumatic valvular lesion.

The palpable mass was due, not as we suspected to an inflammatory lesion of the mucosa of the ileum and ascending colon, but to a marked peri-ileitis and pericolicitis, a remnant of the previous acute inflammation. This case demonstrates that a tender mass may be present in the presence of a healed lesion of the intestinal canal.

It will require the combined experience of many surgeons before the question can be answered whether simple sidetracking effects a real cure in a large percentage of the cases. Even at the present time we can state that some cases may be cured by this simple procedure. This observation which has been made by a number of surgeons is of considerable practical importance. In many instances these patients were first operated upon under the erroneous diagnosis of appendicitis. After the abdomen is opened, the true pathology presents itself. The surgeon, especially in small communities, may not want to risk a removal of the lesion, which undoubtedly represents a major surgical procedure. For this reason in many cases the abdomen has been simply closed up or the normal appendix has been removed, with persistence or aggravation of the symptoms. Under circumstances such as described the surgeon, instead of closing the abdominal incision, should perform a sidetracking operation, a comparatively simple procedure. Meyer states: "Shortcircuiting operations reported by Brown, Borgen and Weber (2), Clute, and others have given relief in about 50 per cent of the patients. In the other 50 per cent the pathological process progressed so that resection of the involved bowel became necessary."

It is impossible at present to answer the question whether simple sidetracking operations will affect a permanent cure in a large percentage of the cases or whether primary resection is preferable. In the presence of fistulous communications

with other parts of the intestinal tract which are frequently encountered in this disease primary resection becomes mandatory.

In closing, I would like to state that Crohn, Ginzburg, and Oppenheimer deserve a great deal of credit for having focused attention upon these interesting lesions. These inflammatory lesions which under the name of infective or non-specific granulomas and similar terms were formerly considered surgical rarities seem to be much more frequent than we were led to believe. Before these authors gave us a clear picture, in many cases an exploratory laparotomy led to a diagnosis of inoperable carcinoma or of tuberculosis. While active discussion as to the etiology and classification of these lesions will probably persist for a number of years, the fact has been established definitely that segmental enteritis is a disease which, in a large percentage of cases, can be cured by comparatively simple operative procedures.

CONCLUSIONS

1. Segmental or regional enteritis is not a rare disease.
2. Opinions differ widely not only as to the pathogenesis of these interesting lesions, but also as to the best method of surgical treatment.
3. This lesion is encountered most frequently in the terminal ileum. However, it may occur in any part of the gastro-intestinal tract.
4. It is doubtful whether segmental ileitis and ileocolitis are clinical entities. They may represent an attenuated form of acute ulcerative colitis and ileitis.
5. Perianal fistulas are frequently encountered.
6. Ileocolostomy with division of the ileum may effect a complete cure.
7. In the presence of fistulous communications with other parts of the intestinal tract primary resection becomes mandatory.

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TABLE I—REVIEW OF 12 CASES OF SEGMENTAL ENTERITIS

Number Year	Name Age	Hospital number	Previous operations	Clinic laboratory operative findings	Operation	Operation	Follow up 1935
1 1934	N K 21	385390	Appendectomy 1 mo previously at another hospital	Jejunum with partial intestinal obstruction	Lateral anastomosis jejunum ileostomy	Klingenstein	Well for 3 years; no recurrence of symptoms Eploration not used
2 1934	T W 19	375033	None	Ileocolitis	Resection of cecum	Lewisohn	Well. Has gained 4 lbs
3 1935	R K 16	381917	None	Ileitis	Sigmoidectomy ileostomy	Klingenstein	Feels well. Has gained 5 lbs. Occasional diarrhea. Tenderness in right lower quadrant
4 1935	H B 21	384528	Drainage of intra- abdominal abscess at another hospital	Ilitis. Large inflam- matory mass with multiple abdominal tenderness	Sigmoidectomy and transverse colectomy	Ginsburg	Perfectly well. Has gained 40 lbs. Sigmoid completely healed
5 1935	L H 17	385416	None	Large inflammatory mass size of grapefruit in region of cecum	Ileotransverse colectomy	Lewisohn	Mass disappeared completely in 2 weeks Patient perfectly well Has gained 60 lbs
6 1935	H H 19	386437	None	Ileocolitis	1 Sept 1935 Ileostomy 2 Nov 1935 Resection of distal ileum ascend- ing and transverse colon 3 Ileostomy for obstruction 4 Enterorrhaphy for perforated ileum distal to ileostomy tube	Klingenstein	Patient perfectly well. Has gained 15 lbs
7 1935	S A 30	380365	Appendectomy 4 mo previously at another hospital. Secondary ileal fistula	Ilitis	1 9 9 Resection of ileum 3 inches above ileocecal valve. Ileosig- moidectomy 2 Jan 1936 Ileosig- moidectomy 3 Ileocolitis 4 Nov 1936 Resection of ileocecal junction and distal half of transverse colon	Willsky Klingenstein Klingenstein	Considerably improved
8 1936	R M 24	392426	None	Ileocolitis. Sigmoid ileum and ascending colon involved	Resection two-stage	Lewisohn	Perfectly well. Has gained 15 lbs
9 1936	S F 24	393835	None	Ilitis 3 ft. with fistula into sigmoid flexure Rectovaginal fistula	Resection two-stage	Lewisohn	Feels well. Has gained 40 lbs in 3 mos. Plastic for recto- sigmoid fistula to be performed
10 1936	G F 39	394502	None	1 Subacute ileitis with very large mesenteric glands 2 Healed ileitis	1 Ileotransverse colectomy 2 Resection of ileum and cecum	Lewisohn	1937 Recurrence of disease. Ilitis above ileocecal junction Resected. Cured
11 1936	D D 17	396217	July, 1936 resection of right ovary on Gynecological Service due to chronic pelvic inflammatory disease	Aggravated ileitis complicated with peri- ectic inflammation Dec 1936 healed ileitis	1 Ileosigmoidectomy 2 Resection of distal ileum cecum and part of ascending colon Closure of multiple fistulas	Ginsburg Lewisohn	Diet adjusted after operation. No recur- rence of disease
12 1936	A K 15	396446	Exploration 6 weeks previously at another hospital	Ilitis	Ileostomy	Klingenstein	Completely well. Has gained 35 lbs since operation. Occasional bowel movements

occurring approximately 24 hours following her second operation.

Anatomical findings. Surgical specimen consisted of 24 centimeters of ileum appendix and 10 centimeters of cecum and ascending colon. The serosal surface of the ileum was smooth and injected. The mucosa of the proximal 11 centimeters of ileum was granular and congested; that of the distal 13 centimeters of ileum pale and superficially scarred. The wall of this portion gradually increased in

thickness to 5 millimeters toward the ileocecal valve. The mucosa over the ileocecal valve was deeply scarred. Pro-
jecting from this area was a cherry sized polypoid pedunculated mucosal polyp. The mucosa of the cecum and ascending colon was pale, flat and the seat of shallow scars and three scattered small pedunculated polyps. The appendix measured 15 centimeters. The mucosa in its proximal 4 centimeters was granular, edematous, hemorrhagic and ulcerated (Fig. 6). Many flat stellate hemorrhagically

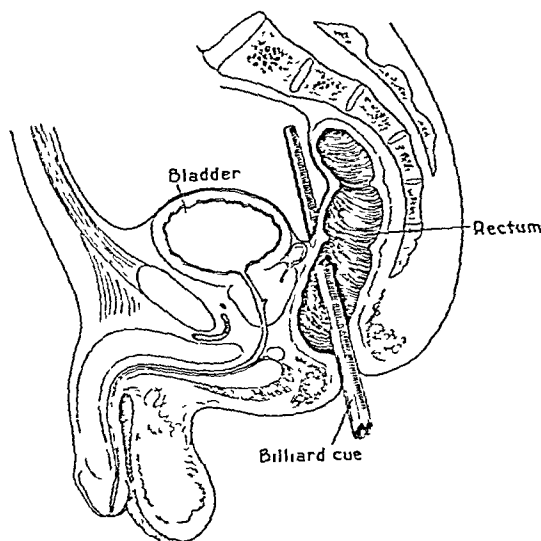


Fig 1 Diagram showing conditions in author's case, true rectal impalement with intraperitoneal involvement. Accident occurred in male child, 11 years of age, and was due to fall on the pointed end of a biliard cue. Laparotomy performed within 4 hours after injury. Recovery following operation.

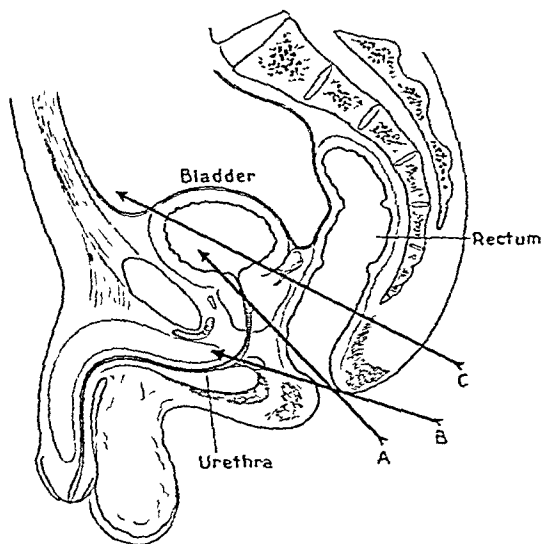


Fig 2 A, Lenormant's (6) case of rectal impalement with associated bladder perforation. B, Gentil's case (6) of urethral laceration following rectal impalement. C, Ravenel's case (13) of atypical rectal impalement with perforation of both walls of the rectum and both walls of the bladder.

Rouques' case report deals with a patient who had a perforation of the lower pole of the left kidney as well as a laceration of the diaphragm, and Ravenel reports a case of intraperitoneal atypical impalement of both walls of the rectum complicated by perforation of both walls of the urinary bladder (Figs 2, 3, 4).

Van Hook's personal case was an intraperitoneal impalement of the rectum of the true type in a boy of 13 years. The patient was operated upon 24 hours after injury and died of a generalized peritonitis.

The greater part of rectal impalements are produced by a fall on the buttocks or a tumble from a height or an elevated spot, and it is curious to note that the greater percentage of reported cases resulted from a fall from a hay loft on to the handle of a pitch fork.

It can be easily seen that the intrarectal perforation is accomplished with a certain violence, the body weight of the patient coming from a height to impale itself with a definite force. It is, therefore, not astonishing to find that the affecting agents which make these very deep lesions may be the blunt ends of objects.

The perforation of the anterior rectal wall at a rather low point is favored by the oblique relation of the rectal wall axis to the plane of the pelvic outlet. It is for this reason that many

of the injuries caused by impalement are limited in their effect on the pelvic tissues.

The impingement of the penetrating object on the parts immediately supported by the bones, and more especially by the sacral promontory, will often limit the extent of the lesion.

As a rule, in cases in which the peritoneum is not involved, the mortality is negligible, but with intraperitoneal injury mortality rates as high as 71 per cent have been reported.

With regard to the age of occurrence and sex incidence there is little of importance noted in the literature in the reported cases. Forty-seven of the 59 cases reviewed by Van Hook in 1896 were males.

SYMPTOMATOLOGY

The symptoms encountered will depend on the location and on the extent of the perforation and also upon whether or not the peritoneum has been involved.

In the pure type in which the inflicting weapon has entered the anus and thereafter pierced the intestine, there may be no local signs present whatsoever. If the lesion is extraperitoneal, the blow having been deviated by some of the pelvic bony prominences, there may be some local signs of hemorrhage, and by proctoscopy a mucosal tear in the rectal wall may be visualized.

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IMPALEMENT OF THE RECTUM

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PERFORATIONS of the rectum by impalement are among the most serious of the unusual accidents necessitating emergency surgical care

That lesions of the rectum acquired in this way have long been objects of study is demonstrated by the various contributions on the subject. A careful historical review of the literature appears in the contributions of Weller Van Hook in 1895 and 1896 and in Quenu's presentations of 1899 and 1900.

In this country Van Hook was the first to review the literature as well as to collect a series of cases. His original article followed his fatal case in 1895, after an intraperitoneal rectal perforation, his young patient succumbed to a generalized peritonitis.

ETIOLOGY

While impalement of the rectum by penetrating bodies has been recorded only infrequently, the occurrence of such lesions is doubtless much greater. The arrangement of the thigh surfaces, of the ischial tuberosities and of the soft parts surrounding the anus have a tendency by their funnel like contour to direct penetrating objects into the rectum.

The morbid anatomy of impaled wounds of the rectum is strongly influenced by the direction in which the object enters the rectum as well as the size and shape of the object. Sharp objects, such as sharpened stakes, picket fences, and handles of pitch forks and goring by horns of animals have been the commonest causes of these injuries in the past. In the case presented herewith, a fall on a billiard stick's pointed end was the impaling implement (Fig 1).

The wounds resulting from this type of injury

fall into two main groups and the prognosis of each type is entirely different.

In the first group, the so called "pure type of impalement, the injury is one in which the piercing object goes directly through the anus, and after passing through the rectum pierces the intestine at a higher level. In other words in this type of accident perforation of the rectum occurs from within the rectum out through the intestinal wall. Fortunately, this is the rarer of the two forms for it is attended with considerable mortality. The case which is detailed in this report is of this type.

The second group which actually comprises the majority of the cases consists of the so called "atypical impalements." Here rectal perforation is secondary to perineal perforation or a wound occurring at some distance from the anal orifice.

The fact that this group comprises the commoner type of injury is probably the reason they are not more frequently detailed. In this variety of lesion the perirectal and pararectal tissues are pierced before the bowel wall itself is perforated. Likewise in this class of injuries there may be either the extraperitoneal or intraperitoneal involvement, depending upon the course of the impaling weapon.

These lesions may become multiple and complicated as when the endopelvic structures with the muscle planes and cellular interstices of the ischio-rectal fossae are involved. Involvement of other viscera with such perforations have been reported, the urinary bladder being the commonest organ affected. Gubal refers to Lenormant's case with a bladder involvement. Gentils case with a urethral laceration. LaMarnere's report of a case with involvement of the adnexa. Bichat and Job's report of 2 cases in which in addition to the large intestinal perforation patients also had wounds of other small intestinal loops (Figs 2 3 4).

TREATMENT

With any sign of intra-abdominal peritoneal involvement, recovery will depend upon early laparotomy with suture of the perforation and drainage.

Prior to operation proctoscopic examination may be of help in those cases in which the impalement is extraperitoneal. For the extraperitoneal and perineal wounds, exploration with incision and packing of the track is urged with symptomatic treatment and careful observation for complicating abscess or fistula formation.

The question of colostomy in an attempt to deviate the fecal stream in those patients with extensive perineal laceration is also a decision that can be made only in each case as such an eventuality arises. In those cases with extensive rectal wall laceration and perineal muscle destruction, this method of aiding healing would seem to be the procedure of choice. It is in such cases that the residual disability often leads to chronic invalidism due to the many pocketings and fistulous tract formation.

CASE REPORT

J. D., a white male child of 11 years, was admitted to the surgical service of the Gouverneur Hospital on August 31, 1936, complaining of generalized lower abdominal pain. Four hours preceding admission the boy was said to have been impaled on the sharp end of a billiard stick after having fallen a distance of several feet.

About 1 hour before entering the hospital he was given a soap suds enema and his parent states that a small amount of blood was found in the return. This measure failed to relieve his pain and he was brought to the hospital for examination. On admission the patient appeared acutely ill and complained of generalized abdominal pain. There was board-like abdominal rigidity which was more marked in the lower abdominal quadrants. His pulse was 110 and his temperature 100. The white blood count was 14,150 with 84 per cent polymorphonuclear leucocytes. A proctoscopic examination was performed but was inconclusive, there being no gross hemorrhage and no visible lacerations in the rectal wall.

Pre-operative diagnosis was that of perforation of the large bowel due to impalement by billiard stick.

At operation, a lower left rectus incision 5 inches in length was made, splitting the muscle. When the peritoneum was opened between clamps considerable grayish seropurulent material oozed forth. With the suction apparatus about 200 cubic centimeters of this turbid fluid was removed from the pelvis.

The small intestinal coils were packed away with warm pads and a few small blood clots were found in the pelvis. The sigmoid and the intra-abdominal portion of the rectum were examined. On the anterior wall of the rectum, at a level with the sacral promontory, there was a longitudinal tear 2 inches in length. The intestine was seized with an Allis clamp at each end of the laceration and several interrupted sutures of No. 1 chromic catgut were placed and tied. A second layer of sutures was placed to infold further the lacerated area and the peritoneal reflection was sutured over the closure.

Two cigarette drains were then placed in the pelvis, one

on each side of the rectum, and brought out through the lower angle of the wound. The abdominal wound was closed in layers down to the drains at the lower angle.

The postoperative course was stormy for the 3 days immediately following operation during which time supportive measures in the form of continuous intravenous saline and glucose were employed. On the fourth day after a spontaneous bowel movement, he was greatly improved and from that time forward his course was one of progressive recovery.

On the thirteenth day following operation a definite fecal discharge was present along the sinus tract at the lower angle of the wound. The discharge continued until the twenty-seventh postoperative day, when the wound ceased to drain.

Shortly before his discharge from the hospital on October 15, 1936, a barium colon enema was performed and the roentgenograph was reported as "revealing the rectum and sigmoid normally outlined. There was no sign of any fistulization, stenosis, or fixation of the rectum. The sigmoid and rectum emptied completely of the opaque mixture thus demonstrating the absence of any mural defect due to the impalement."

He was discharged in excellent general condition 6 weeks after admission with the wound healed firmly.

Follow-up reports have all been satisfactory regarding his general health and bowel habit.

SUMMARY

1. Impalement of the rectum is an unusual surgical emergency demanding immediate attention and care.

2. Two types of impalement are described, the true type and the atypical variety in which the perforation occurs in the adjacent peri-anal region and extends into the rectum.

3. The morbid anatomy of impaled wounds is strongly influenced by the direction in which the object enters the rectum as well as the size and shape of the offending implement.

4. Many injuries due to impalement are limited in extent by the impingement of the penetrating body on the sacral promontory.

5. Of the visceral complications reported with this type of injury, perforations of the bladder are the most common although secondary involvements of the urethra, adnexa, large and small intestine, kidney, and diaphragm have been reported.

6. A case of true rectal impalement due to a billiard stick with intraperitoneal rupture in a child of 11 years is reported with a recovery following operation.

7. Symptomatology will depend upon the location and extent of the impalement and whether the wound is intraperitoneal or extraperitoneal in type.

8. Residual disability in many cases of extraperitoneal wounds of both varieties is due to multiple fistulas and abscess formation and may dispose to chronic invalidism.

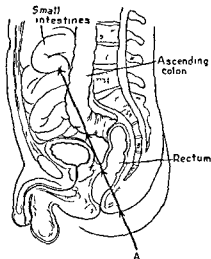


Fig 3 A Bichat and Job's case (6) in which in addition to the intraperitoneal rectal impalement there were perforations of the descending colon and several loops of small intestine

With penetration of the ischiorectal fossae there may be fullness in the perineum associated with localized hematoma formation. Later abscess development may lead to more intense pain and bulging with perineal fistulization.

The constitutional effects, at the onset, may be very slight in this form of rectal impalement, but at a later date with abscess or fistula formation they will be those attendant upon sepsis. In the pure type of impalement in which the inflicting weapon penetrates the peritoneum, in addition to perforating the bowel wall, there is a very different clinical picture.

There may be no local signs present in the perineum, and proctoscopic examination may be quite non-informative. With the involvement of the peritoneum, however, all the immediate signs of acute intraperitoneal visceral penetration will be present. Shock, as manifested by rapid pulse, cold clammy skin, pain in the lower abdominal quadrants associated with localized tenderness and increased muscular rigidity are present. There are also the attendant signs of an acute spreading generalized peritonitis. This type of injury is of a much more serious import and carries with it an exceedingly high mortality owing to the rapidly spreading peritonitis.

In the case reported in this article the tip of the billiard cue entered the anus and perforated the superior anterior surface of the rectum just below the sacral promontory. The laceration which measured 2 inches in length was found

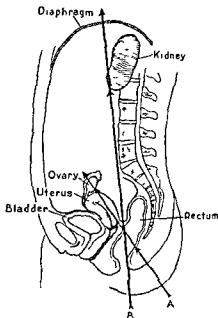


Fig 4 LaMarnière's case (6) of associated laceration of the adnexa with impalement of the rectum. B Rouques case (14) of rectal impalement in which in addition to a laceration of the lower pole of the left kidney there was a perforation of the left dome of the diaphragm

deep in the true pelvis of this young patient. In addition, an acute spreading peritonitis was present at the time of operation some 4 hours after the accident (Fig 1).

Proctoscopic examination prior to operation disclosed no laceration of the mucosa of the rectum and there was no bleeding by rectum.

In contradistinction to the true type of rectal impalement are both the local and the constitutional signs attendant upon the atypical case without intraperitoneal penetration. As a general rule most of the atypical lesions are extraperitoneal although it is evident that there may also be intraperitoneal involvement. When the original site of perforation is a distance from the anus the bleeding may be quite profuse owing to the vascularity of the perineum.

Local laceration, fullness, pararectal tenderness due to hematoma are all common local findings reported in this variety of injury.

PROGNOSIS

It is obvious that the prognosis in both types of injury will depend upon the gravity of the anorectal lesion, the ramifications of the path of injury, and the attendant complications, such as peritoneal or other visceral perforations.

EVIPAL SOLUBLE: BASAL ANESTHESIA

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SINCE anesthesia is rapidly becoming selective, with the trend definitely toward basal anesthesia, we are reporting herein our preliminary experience with the colonic administration of a non-volatile narcotizing agent. Rectal anesthesia is not a new procedure as evidenced by the report of Roux, who in 1847 described the administration of an ether water mixture into the rectum with view to the production of complete surgical anesthesia. In the same year the method of Roux was somewhat modified by Megendie in that he substituted ether vapor for the hydro-ether solution. Neither of these procedures gained in popularity, due to cumbersome apparatus employed and the varying degrees of anesthesia obtained. The status of colonic anesthesia remained stationary until 1884 when Mollerie suggested the administration of ether vapor into the rectum by a hand bellows and subsequent supplemental anesthesia by inhalation. This perhaps is the first record we have of basal anesthesia by the colonic route. Following the report of Mollerie, Wier and Bull published independently concerning their experience with rectal etherization and at the same time called attention to the grave dangers encountered with colonic ether. Other observers extended the original work and confirmed the previous observations, and a number of articles appeared in the press indicating that the methods of administration employed were entirely unsatisfactory since it was impossible to control the stages of anesthesia by measuring the volume of ether vapor administered. Furthermore, frequent reference was made to the high incidence of rectal irritation due to the anesthetizing agent. These observations no doubt served to discourage rectal anesthesia which fell into disuse until 1902, when Cunningham and Lahey (3) reported the successful use of an apparatus designed for the introduction of ether laden air into the rectum. This method of anesthesia presented distinct advantages over the former comparatively crude methods and received wide recognition by numerous anesthetists. In 1910 Sutton constructed a modification of the Cunningham (2) apparatus which permitted the intrarectal administration of ether vapor and oxygen. This procedure was successful but soon fell by the wayside because of the complicated

apparatus and frequent unpleasant by-effects. The next most noteworthy advance in colonic anesthesia was made by Gwathmey, who in 1913 completely described the technique and safety of his well known method before the International Medical Congress in London. Later, in 1915, he published a complete survey of the subject in the *American Yearbook of Anesthesia and Analgesia*.

Gwathmey's method of rectal anesthesia has been used throughout the world and remained without competition until 1927 when Eichols introduced avertin (tribromethanol). The advent of avertin presented numerous advantages over ether since it was possible to calculate the required dosage according to the patient's body weight. Avertin was first employed as a crystalline salt in doses of 120 to 140 milligrams per kilogram of body weight. These doses were necessary in many individuals to obtain complete anesthesia, but today are rarely employed since they are not without danger because of the extreme depression occasionally encountered. Further research with avertin by numerous investigators has popularized it as a basal anesthetic possessing a satisfactory margin of safety when employed in doses of 60 milligrams to 80 milligrams per kilogram of body weight. As with all other anesthetic agents, avertin too has its disadvantages which in the main are: a relatively large volume of fluid, the extreme care necessary in the preparation of solution, the possibility of chemical decomposition due to heat.

In 1936, Gwathmey again revived rectal anesthesia when he reported his experience with the intrarectal administration of a 10 per cent solution of evipal soluble. Here again the dosage is based directly upon the patient's body weight (10 cubic centimeters of a 10 per cent solution for every 50 pounds body weight). In discussing his 150 cases, Gwathmey indicates that the technique employed is simpler and easier than that required for ether and oil by rectum and that evipal soluble is a safe and satisfactory pre-anesthetic medication.

Evipal soluble is a water soluble derivative of barbituric acid known chemically as N-methyl cyclophenyl-methyl malonyl urea. According to Maloney and Hertz, it exhibits a rapid and high hypnotic co-efficient and a very short duration of action, with a toxicity considerably lower than that of other so called short acting barbiturates.

From the Chicago Memorial Hospital

9 Treatment will vary with the individual case but will be determined essentially by whether or not there is peritoneal or other visceral involvement. In extraperitoneal impalements in which there is extensive perineal laceration, the use of colostomy has aided healing immeasurably by allowing the divergence of the fecal current from above.

10 The mortality in these cases is exceedingly high with the intraperitoneal involvement. In some series more than a 71 per cent mortality occurred.

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TABLE II —PROCEDURES ATTEMPTED

Procedure	No of cases
Appendectomies	11
Cholecystectomies	4
Herniotomies	4
Diverticul of sigmoid	1
Cystotomy	1
Nephrectomy	1
Transurethral prostatectomies	2
Bladder fulguration	1
Cystoscopy	2
Pelvic surgery	13
Curettage	3
Radical mastectomy	1
Adenoma of breast	1
Rectal surgery	9
Fracture neck of femur	1
McBride operation (bilateral)	1
Sciatic nerve stretch	1
Thyroidectomies	2
Thyroglossal cyst	1

basal anesthetics, however, the degree of anesthesia and analgesia is very light and is not suitable for surgical procedures. Amentia is always present

Whether the patient is asleep or in the state of seminarcois, supplemental anesthesia is necessary to complete narcosis for a major procedure. We have utilized inhalation, local, caudal, and spinal, and in several instances the pre-anesthetic narcosis was of sufficient depth to permit minor surgery.

A review of the 60 cases presented in this series would indicate that in no instance was there evidence of idiosyncrasy to the drug. This is particularly significant when consideration is given to the variance in the age, weight, and general condition of the patients. The age incidence varied from 9 to 82 years, while the weight varied from 66 to 175 pounds. Generally speaking, the entire group presented a satisfactory risk from a surgical standpoint. A perusal of Table II will indicate the procedures we have attempted under this type of anesthesia.

In these cases we were particularly impressed with the relaxation and reactivity of the patient. Preliminary medication consisted of 1/48 to 1/20 grain of dilaudid parenterally (see dosage table), however, in 3 cases a barbiturate was substituted for the opiate. The latter procedure is not recommended since it almost invariably leads to a confusing clinical picture and frequently results in a prolonged narcosis. The dosage of evipal soluble ranged from 1 to 3 grams, being individualized in each instance in accordance with the age, weight, and general condition of the patient. We purposely varied the type of supplemental anesthesia, as shown in Table III. In 4 cases, however, supplemental anesthesia was not required.

TABLE III

	No of cases
Ethylene	30
Ethylene and novocain	6
Ethylene and ether	3
Nitrous oxide	1
Novocain infiltration	15

TABLE IV.—DOSAGE

Weight pounds	Evipal soluble		Premedication (parenterally) Dilaudid—grains
	Grams	Grains	
45 to 60	0.6	10	1/40
60 to 75	1.0	15	1/40
80 to 95	1.3	20	1/30
100 to 115	1.6	25	1/30
120 to 135	2.0	30	1/20
135 to 150	2.6	40	1/20
155 to 175	3.0	45	1/20

The dilaudid is given hypodermatically 1/2 hour prior to the intrarectal administration of the evipal soluble solution, which is prepared according to the above dosage scheme. The required amount of evipal soluble is dissolved in 30 cubic centimeters of distilled water and instilled into the rectum about 20 minutes before operation.

The average variation in blood pressure was a drop to the extent of 10 to 30 millimeters of mercury. In several cases the pressure was unaffected, while in 2 instances there was a slight increase following the completion of the surgical procedure. Relaxation was generally good and was comparable to that obtained with spinal anesthesia. The respiratory rate showed little deviation from the normal except in two instances, in which it dropped as low as 10 per minute. A postoperative sleep closely resembling the normal was observed to last from 1/2 to 6 hours.

In 2 instances there was a cyanosis of mild degree which cleared up rapidly following the administration of carbon dioxide and oxygen. One patient was a female, 82 years of age, with a fractured femur and a co-existing myocarditis, to whom we administered 1/20 grain dilaudid and 2 grams evipal soluble. A reduction was accomplished under this medication without the usual supplemental anesthesia. The other patient who showed signs of cyanosis was a 31 year old individual with a massive fibroid uteri, to whom 1 1/2 grains of nembutal was given 8 hours prior to the administration of 2 grams of evipal soluble, supplemented with ethylene.

Two deaths occurred in the series, one being a patient with a suppurative appendicitis who died on the ninth postoperative day from a pulmonary embolus. The other individual, who was transfused subsequent to a prostatectomy, expired following an anuria of 7 days' duration caused by

TABLE I—TOXICITY OF BARBITURATES GIVEN INTRAPERITONEALLY

Drug	Mgm. Kilo Minimal anesthetic	Mgm. Kilo Minimal lethal	Therapeutic index
Evipal soluble	25	100	4
Pentobarbital sodium	50	110	2.2
Amytal sodium	80	130	1.6
Barbital sodium	140	450	3.2

eg., nembutal, pernocton, and amytal. Weese has demonstrated that the narcotic dose approaches the hypnotic dose but does not approximate the lethal dose, in dogs the minimal hypnotic dose being 0.026 gram, the minimal narcotic dose 0.030 gram, while the lethal dose is represented as 0.100 gram per kilogram. These figures indicate that the drug primarily affects the sensory and reflex centers in small doses and that the vital centers are unaffected except by comparatively large amounts of the drug. Table I which is taken from the report of Findlay and Findlay indicates the comparative toxicity of barbiturates when given intraperitoneally to rats. Werner and Tatum classify evipal and pentothal as ultra short acting barbiturates.

Numerous investigators have demonstrated that intentional lethal doses of evipal soluble to animals result in death due to respiratory rather than cardiac failure. The liver apparently plays an important part in the rapid detoxication process.

Probably the greatest tribute to evipal soluble lies in the vast number of reports that have appeared in the recent literature concerning its intravenous use as a general anesthetic. In reviewing his 1000 cases, McNelis reports that he has not encountered any alarming symptoms although his patients' ages ranged from 4 to 82 years. In 1 instance he gave a robust patient a total of 40 cubic centimeters of a 10 per cent solution intravenously during an orthopedic procedure which lasted 1 hour.

The intravenous dose of evipal soluble is strictly individualized and is governed according to the reactivity of the patient. The anesthesia produced is rapid, quiet, and of sufficient depth to permit surgical procedures that do not require more than 10 to 20 minutes. Complete recovery is made within at least 30 minutes unattended by nausea, vomiting or excitement. The voluminous reports relative to the intravenous use of evipal soluble are laudatory and indicate that it is a suitable agent for the production of short anesthesia.

Our experience with evipal soluble intravenously has been so satisfactory that we were prompted to employ it rectally after reading Gwathmey's report of its use as a basal anesthetic. The basal anesthetic dose intrarectally, as one would expect, is considerably greater than the intravenous anesthetic dose. Gwathmey uses 0.2 cubic centimeter of a 10 per cent solution per pound of body weight, as an index, that is, a patient weighing 150 pounds would receive 30 cubic centimeters (0.2 X 150). We have from time to time modified this dosage scheme and a review of the cases reveals that we have been prone to effect a slight reduction. A perusal of the accompanying chart will indicate our exploration of minimal and maximal quantities in an attempt to stabilize our dosage. At this writing, however, we are of the opinion that the original dosage scheme suggested by Gwathmey is well within the limits of safety and will produce the desired degree of semiconsciousness in the majority of cases. However, we are inclined to modify the dosage (Table IV). A young robust alcoholic generally requires more than the calculated amount, while anemic, cachectic, and aged individuals usually require only a fraction thereof. Furthermore we feel that allowance should be made for patients who are extremely overweight and in such instances we calculated our dose as the patient's normal weight for his height and age.

The technique of basal anesthesia with evipal soluble is simple. The patient is usually prepared in the customary manner the night before the operation by the administration of the usual sedatives. We prefer luminal in doses of 156 grains or, in extremely nervous individuals we resort to the more powerful narcotics. The next morning the patient is given 1/30 to 1/20 grain of dilaudid 30 to 40 minutes prior to the administration of the evipal soluble solution. The latter is given to the patient in his own room in the simplest manner possible—we employ a milk catheter attached to a glass funnel. From 10 to 15 minutes after the instillation of the evipal soluble the patient is generally asleep and can be transported to the operating room. In some cases particularly when the dose is below a minimal value sleep does not follow in the usual manner and it is necessary to resort to supplemental anesthesia with the patient in a semiconscious state. This has been encountered several times in our series, and it is interesting to note that the patients have no recollection of the previous procedures upon recovery. The sleep produced by evipal soluble is smooth and more closely resembles the normal than that produced by other

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Bladder fulguration	1
Cystoscopy	2
Pelvic surgery	13
Curettage	3
Radical mastectomy	1
Adenoma of breast	1
Rectal surgery	9
Fracture neck of femur	1
McBride operation (bilateral)	1
Sciatic nerve stretch	1
Thyroidectomies	2
Thyroglossal cyst	1

basal anesthetics, however, the degree of anesthesia and analgesia is very light and is not suitable for surgical procedures. Amnesia is always present.

Whether the patient is asleep or in the state of semianesthesia, supplemental anesthesia is necessary to complete narcosis for a major procedure. We have utilized inhalation, local, caudal, and spinal, and in several instances the pre-anesthetic narcosis was of sufficient depth to permit minor surgery.

A review of the 60 cases presented in this series would indicate that in no instance was there evidence of idiosyncrasy to the drug. This is particularly significant when consideration is given to the variance in the age, weight, and general condition of the patients. The age incidence varied from 9 to 82 years, while the weight varied from 66 to 175 pounds. Generally speaking, the entire group presented a satisfactory risk from a surgical standpoint. A perusal of Table II will indicate the procedures we have attempted under this type of anesthesia.

In these cases we were particularly impressed with the relaxation and reactivity of the patient. Preliminary medication consisted of 1/48 to 1/20 grain of dilaudid parenterally (see dosage table), however, in 3 cases a barbiturate was substituted for the opiate. The latter procedure is not recommended since it almost invariably leads to a confusing clinical picture and frequently results in a prolonged narcosis. The dosage of evipal soluble ranged from 1 to 3 grams, being individualized in each instance in accordance with the age, weight, and general condition of the patient. We purposely varied the type of supplemental anesthesia, as shown in Table III. In 4 cases, however, supplemental anesthesia was not required.

TABLE III

	No of cases
Ethylene	30
Ethylene and novocain	6
Ethylene and ether	3
Nitrous oxide	1
Novocain infiltration	15

TABLE IV.—DOSAGE

Weight pounds	Evipal soluble		Premedication (parenterally) Dilaudid—grains
	Grams	Grains	
45 to 60	0.6	10	1/40
60 to 75	1.0	15	1/40
80 to 95	1.3	20	1/30
100 to 115	1.6	25	1/30
120 to 135	2.0	30	1/20
135 to 150	2.6	40	1/20
155 to 175	3.0	45	1/20

The dilaudid is given hypodermatically 1/2 hour prior to the intrathecal administration of the evipal soluble solution, which is prepared according to the above dosage scheme. The required amount of evipal soluble is dissolved in 30 cubic centimeters of distilled water and instilled into the rectum about 20 minutes before operation.

The average variation in blood pressure was a drop to the extent of 10 to 30 millimeters of mercury. In several cases the pressure was unaffected, while in 2 instances there was a slight increase following the completion of the surgical procedure. Relaxation was generally good and was comparable to that obtained with spinal anesthesia. The respiratory rate showed little deviation from the normal except in two instances, in which it dropped as low as 10 per minute. A postoperative sleep closely resembling the normal was observed to last from 1/2 to 6 hours.

In 2 instances there was a cyanosis of mild degree which cleared up rapidly following the administration of carbon dioxide and oxygen. One patient was a female, 82 years of age, with a fractured femur and a co-existing myocarditis, to whom we administered 1/20 grain dilaudid and 2 grams evipal soluble. A reduction was accomplished under this medication without the usual supplemental anesthesia. The other patient who showed signs of cyanosis was a 31 year old individual with a massive fibroid uteri, to whom 1 1/2 grains of nembutal was given 8 hours prior to the administration of 2 grams of evipal soluble, supplemented with ethylene.

Two deaths occurred in the series, one being a patient with a suppurative appendicitis who died on the ninth postoperative day from a pulmonary embolus. The other individual, who was transfused subsequent to a prostatectomy, expired following an anuria of 7 days' duration caused by

the occlusion of the tubules with acid hematin and hemoglobin. Obviously, neither of these fatalities could be directly attributed to the anesthetic.

SUMMARY

1 Basal anesthesia is a rational procedure based upon well established principles.

2 Evipal soluble intrarectally in the proper dosage gives consistently good results as a basal anesthetic when all influencing factors are concerned.

3 The use of evipal soluble according to the method described herein allays the apprehension and fear of anesthesia and predisposes to a much better postoperative course.

4 Pre anesthetic medication with evipal soluble by rectum markedly reduces the normally required volume of supplemental anesthesia by at least 50 per cent.

5 When used in selective doses, the intrarectal

administration of evipal soluble produces a minimal effect upon the respiratory rate, pulse, blood pressure, and body temperature.

6 The results obtained justify its use since it is of distinct aid to the surgeon and anesthetist and contributes to the well being of the patient.

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PILONIDAL CYSTS

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PILONIDAL cysts are by no means rare. In a general hospital, this affection may run as high as 12 per cent of the total admissions (4, 6). Of the 2,515 new surgical cases admitted to the Rush Medical College Dispensary during the past 11 months, 6 cases of pilonidal cysts were found. In the author's series of 3 years' duration, 10 patients have been treated; 6 were men and 4 were women. Rogers (22) at the Massachusetts General Hospital compiled an 8 year summary of 119 cases, 94 of which were males. This high preponderance of males is likewise substantiated in the literature, where 75 per cent of the occurrences have been reported in men (20).

The condition appears to be an affection found principally in stout, well nourished, hairy individuals between the ages of puberty and the late thirties. The youngest patient treated by me was 17 years, while the oldest was 35. All these patients fitted in perfectly with this general description of physical well-being.

Pilonidal cysts may be defined as a congenital anomaly of the sacrococcygeal midline area, characterized by a dimpling pinhole deformity, and apparently unnoticed unless inflamed or discharging an offensive material. The lesion consists of a cyst or sinus tract lined with stratified squamous epithelium and frequently containing hair. The finding of hair may be considered pathognomonic (1). There has arisen, consequently, the various terms associated with this disease, such as pilous cyst, sacrococcygeal cyst, fistula or dermoid, coccygeal cysts, or the present title, pilonidal cyst, a nest of hair. The cases I am reporting answer the description of these terms, 3 of which, however, contained no hair. The remainder all had definite sinus tracts, while one presented a large abscess with cyst formation. In spite of the position of these fistulas, none has ever been reported to have definite connection with the rectum. They have been many times, unfortunately, wrongly diagnosed as rectal fistulas, anal fistulas, ischio-rectal abscesses, and the like.

Numerous theories have been proposed in explanation of the *etiology* and *pathology* of pilonidal cysts. The general finding of hair led to the suggestion that the condition arose from inversion of hair follicles diverted from their normal direction

by some external cause. This ectodermal invagination with arborization (Fig. 1a) has found a number of recent adherents (28, 9). The second theory has as its principal tenet the anomaly of imperfect union of the two halves of the body, thus forming anywhere from a completely cut-off, rolled-over, hollow tube of ectoderm lying subcutaneously (Fig. 1b and c) to almost an entire lack of fusion (14, 2). Third, some (15, 19) considered the condition consequent to an overgrowth of skin during the formation of the nates. It has been suggested that overgrowth of the mesoblast between skin and bone produced an exaggerated dimple. This dimple might lead to a cyst formation by closure at its mouth; or sinus formation, because of attachment and elongation encountered in the rapid growth of bone as compared with skin. Thus the cystic walls might be pulled forward and caudally into a sinus tract.

Lastly, the neural theory considers the cyst formation as an anlage of the development of the neural canal. This was one of the earliest theories proposed, and, with modifications, has many sponsors (5, 27, 16, 10). Just posterior to the primitive groove, the ectoderm thickens, forming the two neural folds. These folds meet in the midline progressing forward and backward. As they reach the most posterior point, they cone outwardly, producing a broad wide opening for the neural groove. Normally, the neural groove closes tightly at the end of the sixth month. In some few cases, however, it remains more or less patent, and there result malformations such as spina bifida occulta (26, 25) (Fig. 2), externa, and the like. In as far as the area is adjacent and adherent to the bony structure of the body, the formation of a sinus tract can readily be understood, the bony parts growing more rapidly than the skin, and if there is attachment to either, the ectodermal rests become stretched into a sinus tract.

As the neural folds coalesce in this region and pinch off from the overlying ectoderm to form the neural cord and canal, ectoderm (Fig. 3) may remain behind, and even a completely well formed continuous sinus tract. This tract may be closed at one or both ends. Consequently, there results a simple isolated cyst, a sinus closed at one end, or one opened at either end, or one even communicating with the spinal canal. A case of

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this description is the suggestion for the present paper. Moreover, there has been recorded neural buds in some of the pathological specimens (11), while meningitis originating from an infected pilonidal cyst has been reported by Moise and Ripley and Thompson. Weeder has observed spinal fluid to escape during the excision of a cystic tract.

Subjectively pilonidal cysts are without symptoms unless infection sets in with the usual sequelae of inflammation. There is then swelling, pain over the coccyx with or without abscess formation around the midline or near either buttock. A discharge may be present consisting of sebaceous material and epithelial debris. This sometimes irritates and produces a pruritus. On the other hand, what the patient considers a pimple or an infected blackhead is the usual first symptom to direct his attention to these parts. Why these complaints, however, should only manifest themselves after puberty is a matter of speculation. Some (7) maintain trauma responsible. If we restrict trauma to accidental injury, then it is not likely that trauma as such, plays a large rôle in the etiology of pilonidal cysts. But in the light of abuse created by pressure, forceful sitting down and the many similar acts done unnoticed during the day, along with the irritation occasioned by the presence of encapsulated hair, then most likely trauma is the principal exciting cause.

As to pathology, pilonidal cysts are formed of stratified squamous epithelium lining the cyst or sinus. If a sinus tract is present the epithelium branches thus producing an arborization. These sinuses may be single with one external opening or many, or the sinus may extend unilaterally, bilaterally, up into the groin (3) or down into the leg. Inwardly the sinus may communicate with the prevertebral fascia, extend directly through and into the vertebral canal, even become continuous with the perosteum, the dural linings (18), or arachnoid.

Besides sweat glands, hair follicles, and hair in the cyst, neural buds (12) with end of nerve tissue have been reported, and observed in pathological sections. Assuredly these latter findings speak in favor of a neurogenic origin. Never has any communication disclosed a connection of the tissue tracts with the rectum, nor has any endodermal tissue been observed in their makeup. The usual laboratory tissue report reveals the presence of such tissue structures as skin, subcutaneous fibrous tissue and muscle, all demonstrating the characteristic findings of chronic inflammation.

The diagnosis of pilonidal cyst is usually made from description of the affection and symptoms

related by the patient. Where there is abscess formation, the diagnosis offers some difficulty. Then the condition may be confused with the differentiating diseases associated with perirectal pathology. By way of illustration, I wish to report a case demonstrating the point in question.

E. L. a young man aged 31 years, complained of an intense itching about the anus. There was some moisture present which caused considerable distress owing to its odor and irritation. The patient athletically active felt himself handicapped and thought by shaving he could keep the parts clean and less worrisome. There shortly developed a swelling over his right gluteal region which he attributed to an infected pimple. Conditions became worse forcing him to seek medical attention. The diagnosis of a rectal fistula with abscess formation resulted in an incision and drainage operation. The patient improved temporarily but soon was forced to undergo a repeated incision operation with equally bad end results. Drainage continued over a period of 3 years and was present when the patient came under my care. The gross pathology resembled very closely a rectal fistula and an excision operation was advised. On the operating table however after the injection of methylene blue hydrogen peroxide solution into the old operative wound no communication of the tract with the rectal mucosa could be seen. Dissection of the abscessed area led to the discovery of a double sinus tract extending from several inches on the right buttock to the median raphe and across to the opposite side about 1 inch (Fig. 4). As the fistula crossed the midline an offshoot was directed posteriorly into a large cystic sac approximately 6 centimeters by 4 centimeters lying to the right of the coccyx bone. This cyst was dissected out and its most anterior end terminated in between the sacro-coccygeal articulation. Disarticulation of the joint revealed that the lining of the cyst was in direct communication with the inner vertebral lining of the sacral body and continuous with the inner spinal canal coverings all of which were clamped off as high as possible ligated excised and allowed to retract inwardly. The coccyx being released the perineal rent was closed with plain catgut stitches. An iodoform vaseline pack placed in the dissected area permitted the wound to heal without suture. The patient has had approximately a 5 years freedom from symptoms and objectively no evidence of recurrence.

TREATMENT

There is considerable discussion regarding the treatment of pilonidal cysts. Summarily, the many methods may be condensed to 1, primary closure with suture (8) after excision of tract; 2, flap transplantation (Lahey method, 13); 3, excision with or without the use of the cautery knife (23) and packing. A recent article (8) sponsors the primary suture method, while another (24) leads one to believe that this sort of operation may be performed under the ordinary conditions of office practice. In the light of the above case report it is difficult to conceive how one can consider the treatment of pilonidal cyst a routine office procedure. No one can predict the extent, direction or involvement of adjacent structures of these sinus tracts, and conse-

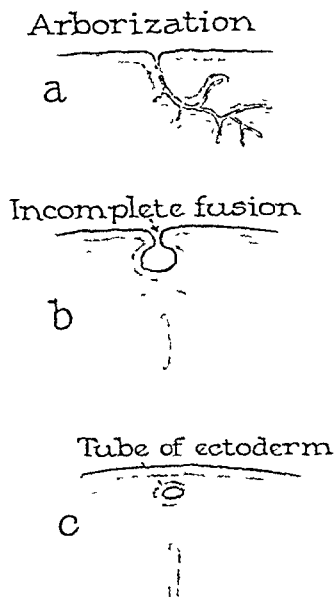


Fig 1 a, Ectodermal invagination and sinus tract formation with arborization b, Defect formed by imperfect union of the two halves of the body c, The two halves of the body perfectly fused, while the roll of ectoderm, as in b, is cut off, lying subcutaneously as a hollow tube or sinus tract

quently, it appears to be as rash to perform an excision of a pilonidal sinus in the office as it is to resort to an equally dangerous practice of injecting with sclerosing material. Surgeons are unanimous in claiming that primary closure never should be done in recurrent cases, nor in the presence of apparent inflammation. Under these conditions, there is no election, excision and packing is the operation of choice. However, it is my belief that careful dissection can be done only under a general anesthetic with preparation commensurate with the uncertainty apparent in the handling of this type of case.

Excision with the cautery knife and cauterization of the epithelial sinus tract are likewise fraught with several dangers, not the least of which is the collection of serum that follows a burn. Primary closure, consequently, under these conditions appears contra-indicated.

Finally, the method of excision with open pack and permitting granulation from below is time tried, and, in our hands, 100 per cent effective. The objection of long debilitation following such operation with protracted stay in the hospital

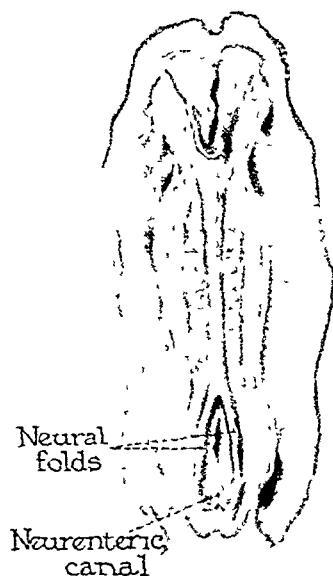


Fig 2 The neural folds in the process of fusing. Arrestment in any stage may produce abnormalities, as spina bifida

and subsequent dressings is not substantiated in fact, nor is the criticism of a resulting large tender scar. The average days in the hospital for the writer's series of cases have been 2, while the

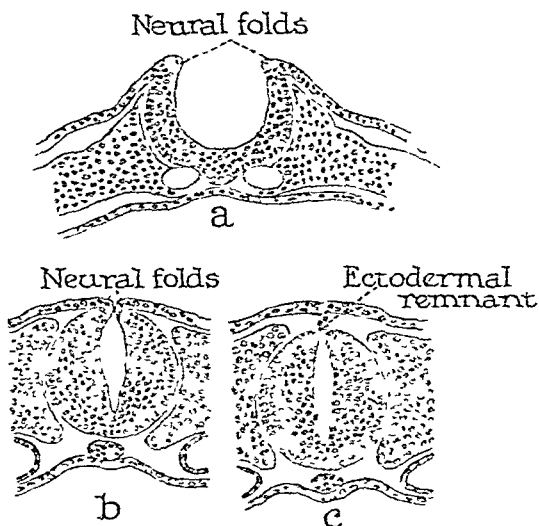


Fig 3 Neural folds in process of producing canal and cord a, Cross-section of early stage b, Partial fusion of the two folds of ectoderm c, Cord completed. Retraction of cord from overlying ectoderm, with ectodermal islets pinched off and lying subcutaneously

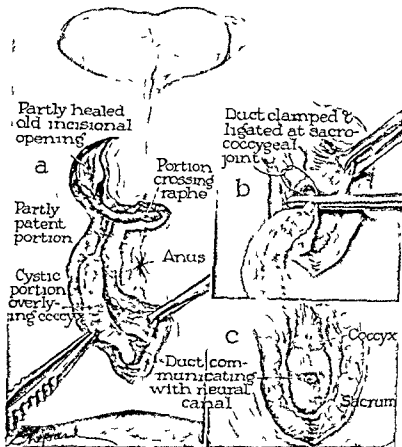


Fig 4 Illustration of an unusual sinus tract found at operation a Tract with cystic portion completely dissected b Ligation of proximal portion of sinus tract at its exit through sacro-coccygeal articulation c Appearance of field after excision of tract

subsequent period of dressing has extended from 6 to 12 weeks a favorable comparison with the other methods. Nor is the patient restricted from work longer than 1 week. An interesting observation is that wide excision in this region is associated with very little pain or discomfort. But even if there were as much pain as one might believe, the extremely low recurrence should offset any of the above objections. Success is judged by the ultimate criterion of recurrence assuredly, then, the last method is by far the one of choice.

Operative procedure. The procedure followed by the author in pilonidal cyst excision consists in the administration of a gas anesthetic while the patient is flat on his stomach. The usual sterile preparation of the operative field having been

completed injection of methylene blue hydrogen peroxide into the sinus opening is done. We prefer hydrogen peroxide to ethereal mixtures, or simple water in as far as the ethereal mixtures are fat solvents and may lead to spurious tract excursions, while the plain water has very little penetration power. Wide excision of approximately 2 inches on each side of the midline is then done and ligation of the bleeding points accomplished by double No. 0 plain catgut. Occasionally curettage of the pre-sacral fascia is required. With this sacrifice of tissue one is not likely to overlook a remnant of epithelial structure. On the other hand wide excision gives us a large area for complete inspection. On one occasion in spite of such wide excision, the knife dissected a small remnant of sinus tract extending upward toward the small

of the back. Assuredly this extension would have been missed had not such a radical excision been performed. An iodoform pack is allowed to remain in the defect for a period of 24 hours. Thereafter, simple vaseline gauze and mercurochrome constitute the biweekly dressings. At each dressing, the small bands of adhesions across the midline are ruthlessly destroyed, and the wound permitted to granulate, filling in from below only.

SUMMARY

Herein is presented a perspective of the literature on pilonidal cysts, including a summary of the more tenable theories as to etiology.

The pathology and diagnosis are discussed, as likewise a review of the methods employed in treating the condition.

The author finally describes a rare case of pilonidal cyst with sinus tract in direct communication with the linings of the sacral vertebral canal.

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THROMBOPHLEBITIS OF VARICOSE VEINS

EDWARD A EDWARDS M D Boston Massachusetts

THROMBOPHLEBITIS is a common condition occurring at some time in the course of about one half of all patients with varicose veins. It is a troublesome, usually painful, rarely a fatal condition. This paper will attempt to show that in spite of the customary cautious attitude which exists among most physicians active treatment of the underlying cause, namely the varices gives quick relief and is not dangerous.

Warnings against active treatment of the varices and the phlebitis are directed mainly against the use of sclerosing injections or operation during the presence of an active phlebitis (5, 16, 4, 27, 35, 25, 12). Several of the writers go so far as to prohibit injections until 6 months, 12 months, or even 2 years have elapsed after the acute attack.

ETIOLOGY

One gathers from the quoted writings that the avoidance of active treatment is based upon the presence of bacteria in the phlebitic veins. The proposition, however, that bacteria are present within the thrombus or the inflamed vein while tacitly accepted, has not yet been proved.

At the outset, the author should like to state that clinically the acute inflammation of phlebitis resembles that of infectious processes and it may be that future work will demonstrate microorganisms responsible for this process. At the present time, however, all the available facts point to the absence of pathogenic bacteria. This thesis has been more fully developed elsewhere (8). Briefly, the evidence against the presence of bacteria are:

- 1 The inability to find them by stain or culture
- 2 The fact that lung infarcts which follow embolism from this source do not go on to abscess formation
- 3 The usual absence of acute inflammatory exudate in the wall of the involved vein or in the regional lymph nodes
- 4 The non involvement of surrounding tissue except in the unusual form of ulcerating phlebitis of the foot described below

5 The fact that operative procedures on the vein including even curettage do not result in sepsis,

6 The presence of thrombogenic factors other than infection, in varicose veins which could by themselves produce a primary thrombosis, and to which the phlebitis could be secondary.

This latter point has not been sufficiently developed, but several factors have been established. They may be grouped into three classes: slowing of the blood stream, physical and chemical changes of the blood, changes in the vessel lining.

Slowing of the blood stream This has been shown by the work of Virchow and latterly by Aschoff to be the most important single factor in producing a thrombosis. It can hardly be doubted that the flow is indeed sluggish in the large sacculculi which constitute varicose veins. This has been demonstrated to the author's satisfaction by the visualization of the venous blood in performing vasography. McPheeters, using this method has published excellent demonstrations of this same fact (22). In his plates may be seen small masses of injected lipiodol floating around within the varices with almost no progressive movement.

The tortuous course of the varices and the presence of outpocketings furthermore produce whorls in the circulating blood. Whorls have been shown to facilitate the deposition of platelets which start the thrombosis (1).

Physical and chemical changes of the blood The cyanosis of a varicose extremity is a good indication of the diminished oxygenation, and deTakats and others (6) indeed found the carbon dioxide content of the blood in varices to be increased above that of the arm veins. This anoxemia is produced first by the stagnation of the blood and secondly by the fact that in severe varices the blood runs downward in the saphenous from the femoral vein. It is thus so to speak supernaturated blood. An increase in carbon dioxide content is said to enable blood to clot more easily, perhaps by increasing its calcium content.

The viscosity and protein content of the contained blood is also increased. An increased viscosity allows easier agglutination of cellular elements. The increase in protein is not wholly due to mere blood concentration as its rise is proportionately higher than the concentration and

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Fig 1 Pylephlebitis, a septic phlebitis. Section of a branch of the portal vein in the liver. Note the intense acute inflammation, the wall of the vein being disrupted by polymorphonuclear leucocytes. Masses of bacteria are frequent. Eosin and methylene-blue stain $\times 180$. (Courtesy of Am Heart J)



Fig 2 Phlebitis of a varicose vein. Note the absence of inflammatory reaction. No bacteria could be found. Hematoxylin and eosin stain $\times 180$. (Courtesy of Am Heart J)

the three constituent proteins, albumin, globulin, and fibrinogen, are not always in consistent ratio (28). Since intravascular clotting has been produced by injections of proteins (29), this increase in proteins may predispose to thrombosis in the varices.

The sedimentation rate in venous stasis is increased, probably due to the increase in fibrinogen and globulin (17, 28). This increased capability of the red cells to settle down would increase the chances for the production of propagated thrombi.

Changes in the vessel lining. These are of two kinds, functional and organic. The functional refer to poor nutrition of the venous endothelium and this is occasioned by diminished oxygenation of the tissues. DeTakats and others (6) have demonstrated this poor oxygenation in showing first that the blood which actually bathes the endothelium within the vein is poorer than usual in oxygen content, and secondly that the arteriolar circulation of the limb, as measured by the histamine reaction, is somewhat diminished.¹

The organic changes in varicose veins are numerous, but it is probably far-fetched to ascribe any thrombogenic influence to any but the

intimal pathology. Here are found changes similar to those well recognized as causing thrombosis in arteries, namely intimal proliferation, vacuolization of the endothelium, and tearing and disappearance of portions of the endothelium. These changes are being investigated further and will be described in detail in a later communication.

To these remarks concerning the background of thrombophlebitis in varicose veins may be added a mention of two incidents which may produce a thrombosis in any vessel but which are very common as precipitating causes of thrombophlebitis in varicose veins. The most common one is trauma. The injury does not have to be a severe one, indeed, it is frequently an accidental kick of a child, or a mere bumping into an article of furniture. The second incident is the submission of the patient to the enforced bed rest, dehydration, etc., occasioned by childbirth, operation, or acute febrile disease.

CLINICAL COURSE²

The thrombophlebitis may start spontaneously or be precipitated by one of the incidents mentioned. It may be acute or chronic. The acute varieties give rise to greatly inflamed, tender, hard masses, somewhat wider than the underlying inflamed and thrombotic varices. The phlebitic process may stay localized to the original segment of vein and may subside in from 10 to 30 days or.

¹Varicose veins may give rise to a diminished arteriolar flow in two ways. The reflux down the saphenous increases the pressure within it. This pressure has been measured by several observers and has been found, under severe strain, to approach arterial pressure. The pressure is not only imparted to the varices, but, continuing through the venules it exerts a back pressure on the capillaries, which may equal the arteriolar pressure.

The second mechanism for the diminished arteriolar flow is to be found in the sympathetic nerve irritation and consequent arteriospasm which tense varices may engender (3).

²Nowhere in this paper is the expression "thrombophlebitis" used for the postinjection reaction in veins.

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EDWARD A. EDWARDS, M.D. Boston, Massachusetts

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Slowing of the blood stream. This has been shown by the work of Virchow and latterly by Aschoff to be the most important single factor in producing a thrombosis. It can hardly be doubted that the flow is indeed sluggish in the large sacculi which constitute varicose veins. This has been demonstrated to the author's satisfaction by the visualization of the venous blood in performing vasography. McPheeters, using this method, has published excellent demonstrations of this same fact (22). In his plates may be seen small masses of injected lipiodol floating around within the varices with almost no progressive movement.

The tortuous course of the varices and the presence of outpocketings furthermore produce whorls in the circulating blood. Whorls have been shown to facilitate the deposition of platelets which start the thrombosis (1).

Physical and chemical changes of the blood. The cyanosis of a varicose extremity is a good indication of the diminished oxygenation and deTakats and others (6) indeed found the carbon dioxide content of the blood in varices to be increased above that of the arm veins. This anoxemia is produced first by the stagnation of the blood and secondly by the fact that in severe varices the blood runs downward in the saphenous from the femoral vein. It is thus, so to speak, supernaturated blood. An increase in carbon dioxide content is said to enable blood to clot more easily, perhaps by increasing its calcium content.

The viscosity and protein content of the contained blood is also increased. An increased viscosity allows easier agglutination of cellular elements. The increase in protein is not wholly due to mere blood concentration as its rise is proportionately higher than the concentration and

From the Departments of Surgery, Tufts College Medical School and the Boston City Hospital. This study was aided by a grant from the Charlton Fund.



Fig 5 The valve in "sclerosing phlebitis" Compare this with the normal valve of the same magnification in Figure 6 The normal cusp is thin and long, only a quarter of it being visible in this view It projects proximally, and as it does so it forms the internal boundary of the sinus In this situation, this thin flexible valve is ready and efficient in preventing back-flow The phlebitic valve sinus has become filled with fibroblastic tissue. This same material has greatly thickened the proximal half of the cusp Most important of all, the inflammatory tissue on the distal side of the cusp has pulled it down and anchored it to the vein wall in this reversed position The valve is therefore stenotic and regurgitant to such an extent that the vein is practically valveless The vein wall itself shows a fibrosis There is no evidence of any thrombosis No bacteria were found in several sections Verhoeff's elastic tissue and Van Gieson's stains $\times 25$

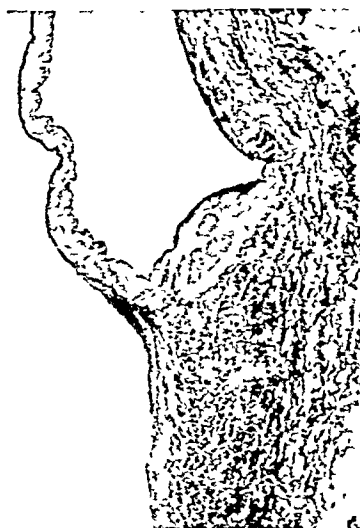


Fig 6 The normal venous valve (saphenous vein) Only part of one cusp is shown. Verhoeff's elastic tissue and Van Gieson's stains $\times 25$

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being considerably narrower than the saphenous, again offer an effective mechanical obstruction With the patient in bed, the blood no longer flows distally in the saphenous but rather in the normal direction toward the femoral vein. Under these circumstances, the thrombus may break off and be carried proximally into the femoral and so to the heart Furthermore, with bed rest a propagation of the thrombus is accelerated, especially, as has been noted, into the deep veins of the leg or thigh Most pulmonary emboli from varicose veins arise from these propagated clots, rather than from the thrombus in the saphenous or its tributaries

As already noted, pulmonary infarcts resulting from these emboli do not give rise to pulmonary abscesses Locally, the thrombophlebitis seems just as bland (Figs. 1, 2). Suppuration has been said to occur but rarely. In actual practice, I have not seen a single instance. Occasionally, the thrombus is not entirely organized but rather

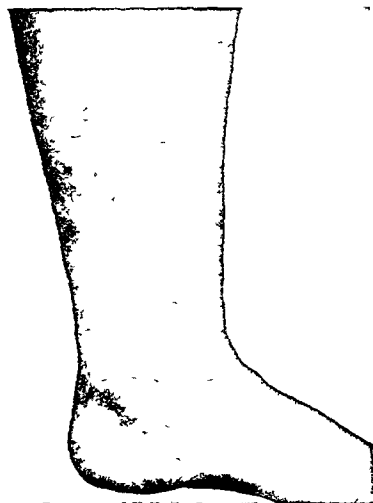


Fig 7 Growth of hair along a phlebitic vein The patient, A J, was a 46-year old woman, referred by Dr Florence Clothier, of Boston Fourteen years previously, after a cesarean operation, she developed a left iliac phlebitis Large varicose veins followed, which were treated elsewhere by ligation in 1934. Due to large incompetent perforators, the hugely dilated varices persisted. In the summer of 1936 a very acute phlebitis was set off in them by a bruise This was followed in 2 months by the growth of hair The phlebitis was finally relieved by a section of the perforators performed during the active process



Fig 3 Ulcerating phlebitis. Below the lateral malleolus is a shallow ulcer while on the dorsum of the foot are several pigmented areas overlying small phlebitic veins. These lesions precede the ulceration.

This patient (H M) was a 43 year old man who in 1910 after a pneumonia suffered a phlebitis of both iliac veins. He then developed varicose veins which were elsewhere treated by saphenous ligation in 1935. The legs were improved but he continued to have attacks of ulcerating phlebitis of the feet each winter. The patient did not have diabetes or syphilis. A culture of the ulcer showed anaerobic staphylococci. He was treated with a vaccine of the organisms and a variety of dressings. Improvement was slow but steady and healing finally took place.

as frequently happens, the inflammation does not wholly disappear but lingers on, so that the process becomes truly chronic lasting from several months to a few years. On the other hand, the chronic process may start as such and in these instances one may find a true phlebitis with only a parietal thrombus or even no thrombus at all. Both the acute and chronic processes are prone to recur, and acute flare ups in the course of chronic phlebitis are common.

While the thrombophlebitis may stay localized, it usually progresses and it is not at all uncommon to find an additional 10 or 12 inches of vein involved in 24 hours. The easiest path of the process seems to be in the system of surface veins. Thus the phlebitis commonly extends upward to involve the entire length of the saphenous, and transversely, to involve its tributaries. Further extension involves the femoral vein by way of the saphenofemoral junction, or the deep veins of the leg or thigh by way of the perforating veins ("perforators"). Ordinarily the thrombus ends sharply at the junction, seemingly because there is such an active flow of blood in the femoral. If the patient is bed ridden, however, as after operation or childbirth, there is a good chance for direct extension to the femoral and I have seen several such cases of femoral thromboses.



Fig 4 Ulcerating phlebitis. section of the pre ulcerative lesion. A vein showing thrombophlebitis occupies most of the section. There is a minimum of reaction in the vein wall and in the surrounding tissue. A few clumps of chronic inflammatory cells are present including macrophages laden with blood pigment. The skin over the vein shows loss of its papillae and an increased desquamation. No bacteria were found by stain or culture. Verhoeff's elastic tissue and Van Gieson's stains. X40.

The patient (J D Boston City Hospital No 64,63) was a 47 year old man who had suffered from spontaneous varicose veins and ulcers complicated by severe diabetes and arthritis. The ulcers were successfully healed by saphenous ligation in 1933. Later the veins of the right leg recurred until a religation was performed in 1936 to section tributaries at the fossa which had been overlooked at the first operation. This disposed of the varices but in the spring of 1937, painful pigmented areas appeared on the lateral aspect of both feet appearing like those seen in Figure 3. Beneath them could be felt the thin hard cords of a phlebitis. One small ulcer appeared on the right foot resembling that seen in Figure 3. The section shown is that of a pre ulcerous area on the left. In this patient healing was effected by means of hot soaks and zinc peroxide paste.

The extension through the perforators is much more common. If the patient is active the deeper parts of the perforators may show only a parietal thrombosis or the complete process may progress into the perforators. Further extension into the deep veins of the leg or thigh is facilitated by the patient being bed ridden but is possible even if the patient is up and about.

Pulmonary embolism from a varicose thrombophlebitis does occasionally occur and may have a fatal outcome. It happens rarely, and perhaps not at all if the patient remains ambulatory. This may be explained by one of two facts. The first is that in all severe varices there is anatomical or at least functional valve loss and a consequent downward reflux of blood in the saphenous. If the patient is erect, the thrombus cannot escape by way of the saphenofemoral junction but is rather jammed downward in the leg. Here it can escape only by way of the perforators (9), which



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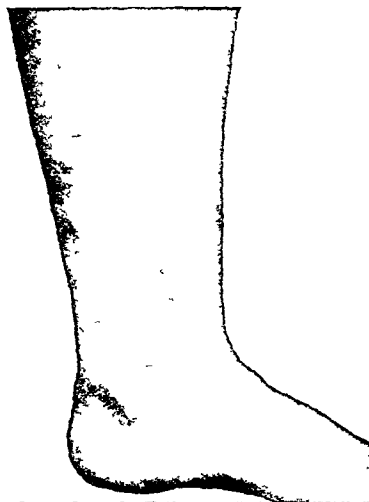


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The patient was a 36 year old, unmarried woman, referred by Dr George Gorham of Roslindale. She had suffered for 20 years with a universal, progressive arthritis, so that all her joints were stiffened and presented only a few degrees of motion. She spent most of her time half reclining in an easy chair. Aside from the chronic arthritis there had been no episodes suggesting phlebitis and no rheumatic fever.

In February, 1933 an ulcer had appeared spontaneously on the medial aspect of the left leg, just above the ankle, and in a few weeks this was followed by a second one a few inches lower. The ulcers were never entirely healed, although 3 weeks' bed rest in 1935 had resulted in their getting much smaller. On resuming her usual restricted activity, the ulcers enlarged to their previous size. The patient was anxious to have the ulcers treated because they gave her considerable pain.

Examination disclosed a thin limb with almost complete ankylosis of hip, knee, ankle, and toes. On the medial aspect of the lower third of the limb were 2 ulcers, one 3 centimeters the other 4 centimeters in diameter. Both were bluish with dull granulations in their bases and with no undermining of their edges. There was moderate brown-black pigmentation above them. The saphenous was made out as a hard cord in which a slight percussion impulse could be transmitted. The Trendelenburg test was not tried. Above the upper ulcer was a soft area suggesting an underlying dilated perforator. Bacteriological culture of the ulcer was done by Dr J B Hazard who reported: "Aerobic culture—*Bacillus proteus*, *Bacillus coli*. Anaerobic (chopped meat)—In addition to gram-negative bacilli, contains a gram-positive coccus occurring in pairs and short chains, probably streptococcus." There was no sugar in the urine and the blood Hinton test was negative.

After 4 days of hot applications of chlorinated soda solution the streptococci were absent and only staphylococci were present. At this time, September, 1936, a high ligation of the saphenous was performed. The vein was small and adherent to the surrounding tissue. It contained a shrunken, thickened valve (Fig 5). Six days after the ligation the ulcers were healed so that the section of the perforators, which had been thought necessary, was not performed. The ulcers have remained healed to this date.

TREATMENT

Varicose phlebitis has generally been treated in a conservative fashion. This has for the most part consisted of rest in bed and the application of ice packs. Such treatment is not satisfactory. The application of ice has a devitalizing effect on the tissues and promotes thrombosis. The enforced rest facilitates the propagation of the thrombosis and increases the chances for pulmonary embolism. It may take weeks or months of such rest before the process quiets down. Foot drop and shortening of the tendo achillis may occur during this prolonged bed rest. Other trophic disorders, such as the growth of hair over the affected vein, are occasionally seen (Fig 7). This resembles the linear growth of hair observed by Louste and Levy-Franckel and by McPheeters (21).

Finally, the long period of disability necessary for this treatment is of no lasting benefit to the

patient. The varices recanalize and sooner or later the phlebitis recurs.

Fischer, in 1910, suggested that phlebitis of varicose veins be treated by the application of a tight bandage and walking. In 1929, Deutsch reported 600 cases, and in 1930 Jaeger reported 100 cases, treated in this fashion with no instances of pulmonary embolism. This was a distinct advance in the conservative treatment since it allowed the patient to stay at his work, diminished the extension of the phlebitis and the chances for embolism.

Starting with Tavel in 1907, who used ligation followed by phenol injections (33), there have been many workers who have disregarded the numerous warnings against the injection of varicose veins in the presence of phlebitis (26, 20, 3, 2). All have reported excellent results by the injection treatment, in the delimitation of the phlebitic process and the subsidence of the inflammation. The injections have generally been used along with the elastic bandage and walking. Such a regimen is a very good one in so far as the active process is concerned, but the closure of the veins produced by the injection is hardly of more lasting effect than that produced by the phlebitis, and recanalization is the rule.

Surgical treatment has also been essayed with good results. The type of operation has varied between curettage of the thrombus, excision of the thrombotic veins, and ligation of the saphenous. Incision of the vein and curettage of the clot was reported by Eisenklam in 1929. He noted no untoward results. The wounds did not become septic, and the inflammation subsided as soon as the clot was removed. This observation makes more plausible the probability that no infection is present and that the inflammation is secondary to a primary thrombosis. This was again advised as one method of treatment by McPheeters in 1931. Excision of the involved segment of vein was reported by Moullin in 1904 as a simple and safe means of cutting short the course of the phlebitis. Homans, in 1928, again reported this as the method of choice.

Tavel in 1904 was apparently the first to advise ligation of the saphenous for its effect on healing the phlebitic process (34). It appears that later he definitely added postoperative injection of 5 per cent phenol to the treatment (33). In recent years deTakats (5) and McPheeters (20) have both recommended ligation when the saphenous is greatly widened. Others have recommended ligation primarily to prevent embolism (32, 31). From the previous discussion it would seem that the prevention of embolism is accomplished mostly

mation has quite well sub sided one or more areas, each from 2 to 4 inches in length become red fluctuant, but not particularly tender. In a day or two, these areas point and open spontaneously, discharging a sterile grumous material. Almost immediately the local inflammation disappears and the tiny sinus is healed within a week.

When a patient is seen with a firm thrombosis of the entire saphenous up to the fossa ovalis, the question may arise as to whether this closure of the vein will not give a spontaneous cure. The answer is, unfortunately, in the negative. I have never seen such a closure remain permanent. Recanalization seems rather to take place faster and more completely than elsewhere in the body, so that at the end of 2 or 3 months a good sized lumen is apparent. The varices then always recur after the resolution of the thrombotic veins.

There is significance in the fate of the venous valves during the course of the phlebitis. With Jesse Edwards I have previously shown that the organization and recanalization of a thrombus results in a destruction of the venous valve (10). We also found that an incomplete thrombosis such as occurs in the upper end of the saphenous or in the perforators, either destroys the valve or produces a stenosis and regurgitation.

The valvular status of the ordinary varicose extremity has been remarked on for about two centuries. The most significant finding in any severely varicose extremity is a relative or absolute insufficiency along the great saphenous trunk and some of its tributaries. Occasionally one or more perforators may also be valveless. There are usually present, however, some normally valved tributaries and normally valved perforators. The additional destruction occasioned by the phlebitis affects whatever normal valves may still be present and throws the veins into the class of full fledged varices. Especially serious is the destruction of the valves of the perforators as this will allow a reflux from the deep to the surface veins. This interferes with the normal return of blood flow, by the pumping action of the muscles and such a limb presents an even more serious impairment of the venous circulation than does the usual varicose limb.

ULCERATING PHLEBITIS

By this expression I refer to a chronic thrombophlebitis of the surface veins occurring oftentimes on the dorsolateral aspect of the foot. This is a very unusual location for varicose veins and indeed these veins are not particularly widened. The process is seen most frequently in patients who have had a deep phlebitis preliminary to

their varices. An itching pain is complained of early, and examination shows an indurated inch or two of vein, with the skin pigmented and adherent to it. In a few weeks the process may resolve or more often the skin sloughs immediately over the vein to give rise to a shallow, painful, and intractable ulcer (Figs 3-4). Section and culture of the vein and skin in the pre ulcerous stage in 2 instances has disclosed no bacteria. Once formed the ulcer does, of course, contain bacteria. Because of the anoxemia in the diseased limb, these are apt to be anaerobic streptococci and staphylococci. The ulcer does not respond to the treatment of the varices above but can be healed by local excision, by the use of local antiseptics (especially zinc peroxide, 2%) by the use of vaccines or non specific protein therapy or by local hyperemia, as by the iontophoresis of metholyl (30).

ASCENDING SCLEROSING PHLEBITIS

By this expression I refer to a form which starts in the normal superficial veins of the lower limb. Its onset may not be traceable to any acute episode as an acute febrile disease or postoperative state. The reason for including it in a discussion of varicose phlebitis is that it gives rise to the same valvular insufficiency and then continues in the now valveless saphenous system. Though the resultant veins are not dilated yet the hydraulics of blood flow are disturbed in the same fashion as in any varicose veins and trophic disorders including ulcer are even commoner.

The disorder usually starts at the ankle as a chronic phlebitis of the superficial veins with or without thrombosis. Quite commonly there is so little disturbance that the patient may be unaware of the process until an ulcer has occurred. Or the patient may present himself for a slightly tender leg with some edema of the dorsum of the foot and ankle, and symptoms of sympathetic nerve irritation, namely coldness and local sweating (8). The process proceeds in several months to ascend in the saphenous and also to involve the perforators. When the active inflammation is over the veins can be palpated as hard cords which on pressure depress the overlying skin into a linear furrow. The ankle is pigmented and an ulcer may be present with all the characteristics of a varicose ulcer. Truly varicose veins cannot be found the vessels seemingly being too tough to dilate.

The course of this form of phlebitis is well illustrated in the case report which follows and also in the figure of a venous valve from the patient (Fig 5).

recanalize as surely as do those involved at a lower level. Obviously, one should handle such a vein gently, but I have never seen recognizable pulmonary embolism following ligation of such a vein, and Dr. Homans has stated that this is also his experience.

The first time the patient is seen, the vein may be so completely closed by the thrombosis that it is impossible to perform the Trendelenburg test or otherwise to determine whether the vein has previously been sufficiently varicose to be valveless. However, since it is the rule that the vein will recanalize and will then be valveless, the operation is indicated just as surely as on those veins which were known to be previously varicose. This brings up the point of "phlebitis in hitherto normal veins" (Homans). Some of these are small varices which have not been recognized as such. Others are instances of idiopathic phlebitis and still others are cases of migrating phlebitis. In the first two, ligation is indicated. Migrating phlebitis, however, is so frequently an expression of Buerger's disease that ligation or injection should not be used. In the light of our present meager knowledge of this condition, these should rather be handled conservatively.

A second operation which must occasionally be performed in these patients is the section of incompetent perforators. The valves of the perforators are apt to be destroyed or become stenotic and regurgitant by involvement in a phlebitis of the deep veins or, as noted, in a phlebitis of the superficial veins. Incompetence of the perforators with a doubly positive Trendelenburg test is therefore seen a little oftener in these patients than in those who have not had phlebitis. My method of handling them is first to attempt healing of the phlebitis and the varices by ligation and injection. If the varices cannot be kept closed by this method, the incompetent perforators must then be sectioned. This operation can be done at the very start, but in most patients healing will take place without it. The technique of the section is that recently described by Faxon and by Linton (Fig. 8).

The subsequent injection of the varices deserves some special mention. While I cannot readily agree that injection stirs up *infection*, there is no question but that it may stir up the *inflammation*. It is a frequent occurrence to see spontaneous attacks of phlebitis in both legs of the same patient so that these veins may be termed thrombophilic. If one injects the veins of every phlebotic patient with the same dose of sclerosing fluid used in uncomplicated varicose veins there may be an extension of the phlebitis

and an increase in the degree of the inflammation. It is best to try out the individual patient's reaction by injecting about 0.5 cubic centimeters of 5 per cent sodium morrhuate the first time, and then increasing this slowly to a total dose of 2 to 5 cubic centimeters at a visit.

If the inflammation is marked to begin with, it is better simply to ligate and to postpone the injections for a week or a month. In the meantime, the reaction will be lessened by hot compresses of magnesium sulphate solution and by exercise. If the patient is an active person with no unusual sensitivity to pain, it is better for him to have a firm elastic bandage or stocking applied after the ligation, and to remain ambulatory. Occasionally, in an older person, or sensitive individual, the patient may stay in bed but should carry out regular exercises. The leg is elevated on one or two pillows. Every 2 hours the patient raises the leg in the air and "bicycle rides" 6 times. If there is much edema, it is well to alternate this raised position with 2 minutes of dependency, as in Buerger's exercises.

I have no figures on the number of patients treated by ligation and injection who had a previous history of deep or superficial phlebitis but they constitute a very large group. In none of them did any serious complications arise and only occasionally did the injections seem to reactivate a superficial phlebitis, which soon subsided. I have never seen a reactivation of a deep phlebitis.

Ligation followed by injection was performed on 63 patients during *acute phlebitis*. Thirty of these were private patients. The 33 others were personally observed and followed at the circulatory clinic of the Boston City Hospital. The postoperative course of the phlebotic patients resembled that of patients with uncomplicated varicose veins. With the exception of 5 patients who remained more than 1 week, the average hospital stay was $2\frac{3}{4}$ days. During this hospital stay most of the inflammatory reaction subsided, and the progress of the phlebitis was stopped. There was no unusual incidence of wound sepsis and not a single instance of postoperative pulmonary embolism. The average time out of work was only slightly longer than that in the uncomplicated cases, 1 to 3 weeks as compared with 5 to 10 days. In an occasional patient the inflammation subsided slowly or was stirred up by the subsequent injections, but this rarely confined the patient to bed.

Not only is the attack of phlebitis arrested but at the same time the varices are treated. The patients have been followed from a few months



Fig 8 The technique of section of incompetent perforators as suggested by Linton (Perforating veins whose valves are incompetent) Since most of the perforators run into the posterior tibial veins the incision is usually placed medially. As the deep fascia is turned forward the perforators are seen in little clumps often in association with a small artery. Those previously involved in phlebitis are apt to be surrounded by scar tissue. All visible perforators whether apparently normal or abnormal are doubly ligated and sectioned. Insert shows a perforator entering a varicose vein in the superficial fascia.

through the ligation allowing the phlebitis to heal and diminishing its propagation to the deep veins.

Comparing the various forms of treatment suggested it would seem that it would indeed be best to attack the varices proper, provided this attack would not increase the phlebotic process nor the chance for embolism. In practice treating phlebotic varices as though they were uncomplicated varicose veins gives good results. Reference is made to the ligation of the saphenous at the saphenofemoral junction, later followed (if

some of the varices are patent) by injection of the varices. The patient does not have to wait until the acute process is over, for the treatment relieves the phlebitis, probably by removing the pressure of the overlying blood. Ligation is therefore done at once. I reported on this treatment in 1934 and subsequent experience has convinced me it is the method of choice (9).

The operation has been performed on several veins which have shown a thrombosis right up to the saphenofemoral junction, since these veins

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to 5 years, and to date no patient has shown a recurrence of either the varices or the phlebitis

SUMMARY

Thrombophlebitis is a common complication of varicose veins. Left untreated or treated by the older method of rest in bed, it progresses in the surface veins and by way of the perforators to the deep veins. It is especially from this deep extension that pulmonary embolism may occur. The disability of the disease extends over weeks or months with recurrence of the varices and the phlebitis the rule.

Warnings against a direct attack on the varices during the period of phlebitis has for the most part been based on the assumption that phlebitis is due to infection. Actually, this infection, though possibly present, has never been demonstrated. There is more evidence that a primary thrombosis occurs due to factors inherent in the varicose widening, and that the inflammation of the vein is secondary to the presence of the thrombus.

The most effective treatment is based on the attitude that the phlebitis is but a complication, and the treatment is immediately directed against the varices. It is therefore very similar to the treatment of uncomplicated varicose veins. It consists of a ligation of the saphenous at the sapherofemoral junction, this being followed by regular exercise and if necessary by the application of heat. Injections of sclerosing solution can be used if some of the varices are still open but should be given in small doses as otherwise the inflammation may temporarily be augmented. Sixty-three cases have been treated in this way with entirely good results. The special advantages of this treatment are the brief period of disability (1 to 3 weeks), the lessening of the chance for pulmonary embolism, the prevention of further damage of the valves of the perforating or deep veins, the prevention of recurrence of the phlebitis and the simultaneous and immediate treatment of the varices.

Two special forms of varicose phlebitis are described. The first ulcerating phlebitis refers to a thrombophlebitis of the surface veins at the ankle and on the foot. Almost invariably the skin over these veins becomes adherent to the vein and sloughs forming ulcers which are resistant to treatment. For their successful cure they require local excision or amputating treatment.

The second form 'chronic sclerosing phlebitis' is a spontaneous chronic inflammation of the surface veins of the leg which goes on for months or years and ultimately cripples or destroys the

valves of the saphenous system. For this reason, these patients have the same trophic disorders that ordinary varicosities give and must be treated in the same way.

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EDITORIALS

SURGERY

Gynecology and Obstetrics

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FEBRUARY, 1938

CONCERNING THE HEREDITARY NATURE OF CANCER

DESPITE the unceasing efforts of scientist, surgeon, and radiotherapist, the problem of cancer baffles all attempts at solution. Many cures are achieved, sometimes when least expected, yet the origin of cancer, and its nature, remain unsolved. That its increasing spread will threaten human existence has been predicted. Faced by cancer in his immediate family, man's innate fear is betrayed by his perennial question "Doctor, is it catching?" Moreover, a folklore superstition as to its familial character hauntingly disturbs his peace. To prevent awakening in him an unnecessary dread of the future, his doctor usually assumes an attitude of reassurance, and is wont to minimize the hereditary nature of cancer.

Convincing evidence against this attitude is provided by Maude Slye's brilliant contributions from the experimental laboratory. Additional corroborative evidence is available from the following clinical experiences:

A family. A young girl, 18 years of age, still living has had her right breast removed for cancer. Her mother died at 47 of bilateral carcinoma of the breast, one maternal aunt, still living, has had both breasts removed for cancer; a second maternal aunt, still living, has had one breast removed for cancer. Her maternal grandfather died of cancer of the colon. One maternal great aunt died of bilateral cancer of the breast. A second maternal great aunt died of cancer of the uterus. A maternal great-great aunt died, aged 40, following bilateral mastectomy, presumably for carcinoma.

B family. Three brothers died of carcinoma of the prostate. The mother had died of a pelvic malignancy, presumably of the reproductive organs.

C family. A young girl died at 30 of cancer of the breast. Her paternal grandmother had died at 26 of cancer of the breast. A maternal aunt had died at 49 of cancer of the kidney; a maternal uncle had died at 45 of cancer of the stomach; her maternal grandmother had died at 55 of cancer of the stomach.

D family. A patient under treatment for cancer of the tongue gave the following family history: A sister died of cancer of the tongue. Her father died of cancer of the jaw. A paternal uncle died of cancer of the hip and a son of this uncle died of cancer of the jaw.

E family. A patient under treatment for inoperable cancer of the cheek and jaw gave the following incredible history: His paternal grandfather died of cancer, site unknown. His paternal grandmother also died of cancer, site unknown. His father died of cancer of the face at 90. Three paternal uncles have cancer of the face or jaw and three paternal aunts have cancer of the breast. The son of one of his paternal uncles has cancer of the face.

These striking examples from a small clinic strongly substantiate the conviction in the minds of many writers that there exists a hereditary factor in the development of cancer.

McKenney's mournful record of two families of 46 members, 37.7 percent of whom have or have had polyposis of the colon, followed in these up to the present time by death from cancer in 44 percent, provides additional arresting evidence. As concrete proposals in the campaign to eradicate or to limit cancer, the following suggestions are made:

A NEW McDONALD'S SOLUTION

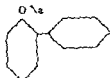
FRANCE McDONALD M.D. C.M. F.A.C.S. Philadelphia, Pennsylvania

TWENTY TWO years ago, I published the results of experimentation upon a new solution for disinfection of the hands and abdominal skin before operation. This came to be known as McDonald's solution.¹

Fourteen years ago I published a review of the results with that solution along with some other work on disinfectants, drawing attention to the fact that at that time para hydroxy diphenyl was considered to have the highest germicidal value.²

There was a hope that a pure substance might be found to take the place of the heavy tarry extract which with acetone and alcohol was the basis of the original solution.

Para hydroxy diphenyl, while perfectly satisfactory for the alcohol acetone solution, is not soluble in water. A better substance has been suggested to me by Mr Leland Doan of the Dow Chemical Company and this has now been used by me and a number of surgeons for 7 years. It is sodium ortho-phenyl phenate with this structural formula and is more potent than the old solution.



The new solution

Sodium ortho phenyl phenate
Sodium oleate
Acetone
Alcohol 92%

1 part
2
2
600

This solution has the advantage of dissolving the fat in the skin and allowing penetration of the sweat glands etc. It is not neutralized by organic matter or soap. Sodium ortho-phenyl phenate has a phenol coefficient of 18 against the typhoid bacillus.

The following directions in the use of my method are given as it is very commonly misunderstood.

(McDonald Ellise Surg. Gynec. & Obst. 1913 31 83)
(McDonald Ellise Am. J. Obst. & Gynec. 1923 Oct. vol. 41)

From the Bio-Chemical Research Foundation of the Franklin Institute

Directions for disinfection of the hands (McDonald method) As washing the hands with soap and water has little or no effect upon the bacteria of the skin even if kept up for 15 minutes it is advisable that some germicide should be added to the wash water. This germicide should be one which is not neutralized by soap or organic matter as contained in the skin, so the new solution one part to 30 of water is used in the basin of warm water.

The area under the nails is the most difficult place to disinfect and, therefore particular attention should be given to the introduction of the germicidal solution under the nails. Nail brushes should be used for the nails only and wash cloths for the hands and arms.

1. Wash the hands in soap and water, containing McDonald's solution 1:30 in a basin for 2 minutes. Scrub the nails with a nail brush and the hands and arms with a cloth. This solution may be used repeatedly. This thorough scrubbing is done only at the first operation and after this the time may be reduced to 2 minutes.

2. Keep wooden orange sticks and nail files in McDonald's solution and do the toilette of the nails, making an effort to introduce the solution under the nails by means of the wet nail file and orange stick.

3. Hands should then be washed in McDonald's solution for 3 minutes scrubbing the nails with the nail brush and using a cloth for the hands and arms. The solution should be at least 3 inches deep in the basin. The hands are then dried and prepared for gloves.

Preparation of patients Shaving the night before operation should be done with water containing McDonald's solution 1 part to 30 parts of wash water. In this way the shaving water will be a germicidal solution and will disinfect, and as the skin is again disinfected the next day, fractional sterilization will be practiced. At operation the dry towel is removed and the area of operation rubbed lightly with a small towel or piece of gauze saturated with McDonald's solution for 3 minutes. The skin is lightly dried and the alcohol and acetone evaporate very quickly leaving the site of operation ready for the incision.

operation of such an instrument. The confusion of thought that exists regarding surgical diathermy probably results from failure to recognize that surgical diathermy differs from electrocauterization in mode of action and in effect. The wire loop, at the end of the electrocautery handle, is made of an electrically resistant metal which becomes red, or even white, hot when a current is passed through it. The electrocautery destroys tissues by conduction of heat from this hot loop to the tissue. Surgical diathermy, on the other hand, utilizes an electric current of high frequency; this current will not produce an electric shock if allowed to pass through the tissues of the body, rather it produces destruction of the tissues because they offer resistance to the flow of the current. When the current is concentrated in the tissues at the tip of a needle, varying degrees of endogenous heating, or even actual disintegration of tissue will occur when the tip is applied to it. Unlike the cautery, the needle at the end of a surgical diathermy handle is constructed of metal of low electrical resistance. The needle, therefore, remains comparatively cold, but the tissue near the needle or in contact with it offers resistance to the flow of the current from the needle. The tissue, therefore, is heated or desiccated. Surgical diathermy is so frequently regarded as a form of cauterization that an explanation of the differences in the mechanism involved seems essential. Not only are the cautery and surgical diathermy entirely different in construction and effect, but also the accuracy of control of the latter is much more delicate than that of the former.

Monoterminal application of surgical diathermy, in which the active needle is attached to a single terminal of the diathermy machine by an insulated wire, is spoken of as "fulguration" or "desiccation." Fulguration is accomplished by holding the needle a short distance

from the lesion which is then showered with sparks and carbonized. Desiccation is accomplished by placing the needle in contact with the lesion, or by inserting the needle within the lesion. With this slight exception the procedures are practically identical, and the terms "fulguration" and "electrodesiccation" are often used synonymously.

Biterminal application of surgical diathermy consists of attaching the needle to one terminal of the diathermy machine by an insulated wire. A large "indifferent" plate is placed in contact with the body of the patient at some site remote from the lesion. This is attached by means of a wire to a second terminal of the diathermy apparatus. Biterminal applications are used in electrocoagulation and in electrosurgical cutting.

High frequency oscillating current used in fulguration, electrodesiccation and electrocoagulation is a damped current, that is, the amplitude of successive vibrations varies by gradual change from a maximal to minimal degree, and from minimal to maximal degree. This sequence is continuous. Such a damped current is produced by the spark-gap type of diathermy machine. On the other hand, high frequency oscillating current used for cutting tissues, is undamped, that is, the amplitude of successive vibrations does not vary from the maximum. Such an undamped current is usually produced by means of the tube (or valve) type of diathermy machine. Whereas a damped high frequency current tends to coagulate tissues, an undamped current causes actual disintegration which results in solution of continuity of tissues; this latter type of current is called the "cutting" current. Fulguration or desiccation produces very superficial carbonization, or destructive dehydration of tissue. Electrocoagulation, on the other hand, is applicable to the destruction of large malignant growths. An entire growth may be

That the genetic factors in the development of human cancer be accorded greater importance

That the multiple occurrence of cancer in a family, or in two generations demands a frank discussion with other members of that family and with members of succeeding generations concerning the known hereditary aspects of cancer. Alarming prophecies are unnecessary and unwarranted, but such a discussion with those members vitally concerned would unquestionably evoke the greatest co operation from them in undergoing periodic health examinations in promptly seeking advice for painless and to them insignificant lumps, in avoiding or in eliminating sources of irritation, and even in restricting further reproduction

That the multiple occurrence of cancer in a family or in two succeeding generations is sufficient medical and legal evidence to warrant sterilization when desired, or abortions when necessary. The question arises also whether, ultimately for the good of the race compulsory sterilization might in certain instances, be desirable

That the marriage of two persons both members of cancerous families be preceded by explicit instructions concerning birth control, or by sterilization of the male in a manner revocable later if desired

That the familial characteristics of human cancer be the subject of intensive clinical study. The greater accuracy of diagnosis and the greater accessibility of proper care to all patients make such a study more trustworthy and more practicable now than formerly. To make the necessary facts available for study and integration it is suggested that the American College of Surgeons be made a repository for the complete records of all authenticated cases of familial cancer including microscopic slides, descriptions of cases,

family trees, and present progeny. Once so documented and recorded, the members of a given family may be subjected to more intensive studies concerning the anatomical, physiological and environmental factors inherent in this family. Such a study requires the assistance of a perpetually available organization like the American College of Surgeons to insure continuity from generation to generation. Indeed the Fellows of the College in their various communities could, quietly, without public discussion or neighborhood gossip place families on record for future study by successive generations of Fellows all to the ultimate benefit of medical science and therefore of humanity

EMILE HOLMAN

ELECTROSURGERY

ELECTROSURGERY may be considered under three divisions (1) time honored electrocauterization, (2) surgical ionization now seldom used, and (3) surgical diathermy which is most important. Electrocauterization needs little description as the principles underlying its use are well known to all surgeons. Surgical ionization plays a minor rôle in the treatment of superficial lesions and in the process of epilation. Destruction of tissue is brought about by concentration of caustic acid or alkaline ions in the tissue in contact with a needle through which a constant electric current is allowed to pass.

Modern surgical literature is replete with references to surgical diathermy. This form of electrosurgery merits careful consideration. The surgeon's chief concern is not with the construction of a complicated electrosurgical instrument rather, it is with the possibilities that such an instrument may offer in the treatment of surgical conditions. Nevertheless, it is well to understand certain principles of the

Electrosurgery undoubtedly has produced radical advances in transurethral surgery. Scott has found it of value in other forms of genito-urinary surgery, such as in removal of calculi or in resection of the lower pole of the kidney.

In the hands of such men as Kelly and Ward, electrosurgery has found extensive use-

fulness in gynecology. The coagulating current has been used most widely for the destruction of many minor cutaneous lesions as well as of extensive superficial malignant growths.

Certainly, electrosurgery should merit the continued interest of all surgeons.

FRANK H. KRUSEN

coagulated and removed *en masse*. There is a tendency for the blood vessels and lymphatics in the surrounding tissues to be sealed by thrombosis, thus minimizing the danger of hemorrhage, shock and dissemination of malignant cells.

A modification of the method of electrocoagulation is produced by the employment of two electrodes, such as two needles, or two prongs of a clamp. By the use of this technique coagulation of tissue will occur only in the region that lies between these electrodes.

Various designations have been applied to the apparatus used for electrosurgical cutting such as, 'radio knife', 'electrothermic knife,' 'Bovie knife,' 'endothermic knife,' and 'acu sector'. The last term coined by Howard Kelly, is derived from the two words 'acu' ('with a needle') and 'seco' ('I cut'). By use of this method the tissues are cut rapidly or slowly, the needle dividing the tissue "as a knife cuts butter". Histologically two zones of tissue may be observed. There is evidence of molecular disruption in the zone adjacent to the incision, in the zone immediately beneath this one there is evidence of elongation of the tissue cells and slight coagulation. Properly applied, the 'sector' (cutting needle) coagulates the wound so slightly that there is a minimum of interference with the process of healing, and there is usually marked diminution of oozing from capillaries.

Nelson Lowry said "There have been two distinct schools in electrosurgery, the cutting school and the cooking school". It is generally believed that the surgeon who utilizes both "cutting and cooking" (electrocoagulation) in each operation will obtain the best results.

Howard Kelly and his associate Grant Ward stated that the demand for electrosurgery had occurred because of the inherent imperfections in operative technique. The necessity for ligation of blood vessels, the possibility of dis-

semination of infectious agents or malignant cells, and the inability to obtain adequate hemostasis in inaccessible parts of the wound are for the most part obviated by the use of electrosurgical technique. Only those who are inexperienced in the use of high frequency current encounter much difficulty. Kelly and Ward stated that the delay in acceptance of electrosurgery by the medical profession probably was attributable in part to the fact that the apparatus was still in the stage of development and in part to lack of persistence in the attempt to develop a technique for its use.

Surgical diathermy has proved particularly efficacious in certain surgical procedures, and in time, as new techniques are developed, it will undoubtedly be more extensively used. Already it has acquired a definite place in the field of neurosurgery. Cushing was an enthusiastic advocate of electrosurgery, and Adson applies it routinely for hemostasis in various types of neurosurgery.

Kirschner of Germany, published reports of 250 cases in which electrosurgery was used. He advocated its use, particularly in amputation of the breast for carcinoma, and in operations on the thorax especially in resection of a rib or in thoracoplasty. Heymann observed that electrosurgery was effective in incision and enucleation of furuncles and carbuncles and in the eradication of extensive collections of purulent material. Hesse was of the opinion that electrosurgery is of special value in the treatment of malignant diseases of the nose and throat particularly small malignant growths of the larynx and of the maxillary sinuses.

A number of authors Mock, Tinker, Jackson and Heymann have enthusiastically advocated the use of surgical diathermy in operations on the thyroid gland, particularly in operations necessitated by the presence of malignancy or toxic exophthalmic goiter.



THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE recent book¹ by Dr Hollender and collaborators satisfies a need of otolaryngologists. It deals with every form of physical therapy that has been used in the treatment of diseases of the ear, nose, and throat.

From the earliest time physical therapy in some form has been employed by all physicians in this specialty. Not many years ago physical therapy included the use of little more than heat or cold, wet or dry applications, light or darkness. Now it involves among other things heat from many sources, light of many varieties, electricity produced by numerous machines, and radiations of various kinds. The field is extensive and complex. The technical phases of the subject are handled in a very satisfactory manner by Dr Hollender. The details are sufficiently described in terms that are easily understood.

As a guide to technique in physical therapy in otolaryngology Dr Hollender's book has real value.

ELLISON L. ROSS

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should be particularly helpful to the student and general practitioner.

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1 Broadway Park
New York
President Lincoln May 11 1862

Dear Sir,

As a private citizen
I give permission to you to publish your own
a subject that is true to our plan
I have heard -

The Labor Union in England
- take notice of a few laborers
in the accompanying pamphlet
with explanation. It is our
purpose to do this later on.
- I wish to see from the beginning
as the labor union is
- true - it is also the foundation
of the labor union -
and the labor union -

sent me by the committee within a
few days - they asked if you
it down the very early edition
and was not told not to have
any more sent in - the paper
the same was not signed
any private committee for a day
- done - Yours truly
(Mott)



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source book of the recent literature. It is hoped that the authors may continue this fine work of assembling in abstract form all the information relative to this timely and important phase of medicine.

I. L. WAINE

LITTLE new can be said concerning a work such as *A Textbook of Histology* by Jordan which is so well established among those modern textbooks of human histology designed especially for medical students. Since the first appearance of Professor Jordan's text there have not been any radical changes from edition to edition although during the years there has been a definite steady trend toward improvement. Especially is this true of the illustrations which in the current edition show 30 meritorious replacements. On the other hand the present volume contains so few textual alterations that the subject matter as a whole cannot be said to have been seriously disturbed. One shortcoming of the preceding edition was its bulky size and burdensome weight. Considerable reduction has now been effected although this could well be carried still further without introducing any appreciable loss. Moreover one again questions the wisdom of including a section on laboratory directions and especially so when the instructions are so individualistic as to be of no real usefulness outside the author's own course. Possibly the criticism of unnecessarily adding to bulk can be directed equally against the section on histologic technique. Since these two sections total 85 pages, they add materially to a volume already overly large for convenient handling.

The number of editions run through since 1916 attests to the continued success of Jordan's *Histology*. It remains a welcome and helpful member of the tried teaching texts in this country. Though not the leader in its field it possesses many valuable features and must rate high among the more ambitious texts of medical histology.

L. B. AREY

THE *Atlas of Hematology*² was written primarily for the clinician, student and technician rather than for the hematologist. Dr. Osgood is responsible for the descriptive part of the text whereas the colored illustrations were drawn by Ashworth. The first half of the book contains 325 colored illustrations, mostly of individual blood cells magnified 2500 times. One or more illustrations of practically every known type of blood cell are included. The coloring and architecture of the cells are extremely accurate and realistic. One should experience little difficulty in identifying cells in a blood film with the use of these illustrations. General characteristics of each cell group are described along with their occurrence in health and disease. Each cell is numbered and described individually.

The author expresses a polyphyletic view of blood formation. He believes that the various specific blast

cells are not formed continuously from the reticuloendothelial system after fetal life. An entirely new nomenclature is recommended, the most radical changes being in the erythrocyte and granulocyte series. Although the reasons given for these changes are logical, such terms as rhabdocyte, lobocyte, akaryocyte, etc., can have meaning only to the unfamiliar with the atlas. Throughout the book the newer terminology is given preference but is always followed by the more familiar terminology in parentheses. As the book was written for general usage it seems that the new terminology could well have occupied a less prominent place.

Some hematologists will take exception to such views as (1) the typical cell in infectious mononucleosis is a polymorphocyte, (2) plasmocytes develop from plasmoblasts, (3) fenestrations in the lymphocytes might be the only differentiating point in the blood smear between infectious mononucleosis and subacute lymphocytic leucemia, and (4) the red cells in individual with ovalocytosis are not elliptical nor as a rule oval. Illustration No. 27 is a lymphocyte with a clover leaf shaped nucleus. The reviewer has seen this abnormality frequently in smears made from venous blood that contained too much oxalate as an anticoagulant.

The second half of the book is devoted to a rather complete description of hematologic diseases, special emphasis being given to the laboratory findings and differential diagnosis. Such chapters as (1) the differential diagnosis of splenomegaly, hepatomegaly and lymphadenopathy, (2) the differential diagnosis of sore throat and stomatitis, and (3) the hematology of infectious diseases should be of great value to the clinician. There are some minor points which are open to criticism. For example, acute hemorrhage is not considered as a cause of macrocytosis. It is stated that an idiopathic form of aplastic anemia is only supposed to occur. The dose of 3 to 6 grams ferrous sulphate daily in the treatment of iron deficiency anemia would seem rather excessive. Some of the newer literature on coagulation of the blood (e.g. prothrombin and the deficiency in hemophilia) is not included. The use of the terms, simple leucocytosis for counts ranging from 4000 to 40,000 per cubic millimeter and simple leucopenia for counts from 2000 to 14,000 is not clear.

The twenty-two tables contained in the text should be of great assistance in the identification of blood cells and in the differential diagnosis of various blood diseases. Frequent reference is made to information gained from sternal puncture and bone marrow cultures. Many original investigations are presented here for the first time.

The author is frequently dogmatic about controversial subjects. This is not objectionable as it furnishes a stimulus to the hematologist and at the same time does not detract from the clinical value of the book. This excellent atlas can be highly recommended to the clinician for solving various hematologic problems and to the student for learning the subject of hematology.

HOWARD J. AIT

¹ A Textbook of Histology, by Harvey Ernest Jordan, A.M., Ph.D.
7th ed. New York: D. Appleton & Company, Inc., 1937.
² ATLAS OF HEMATOLOGY, by Edwin E. Osgood, M.A., M.D., and
Clifford M. Ashworth, San Francisco: J. W. Stiles, Inc., 1937.

THE book¹ by Dr Courville does not conform to the usual plan of texts dealing with neurological pathology, inasmuch as a generous portion of the subject matter deals with clinical symptoms, and even treatment is suggested for some of the pathological entities which are discussed. Naturally, few authors dealing with pathology show any marked degree of interest in symptomatology, but Courville is both a neuro-psychiatrist and a neuro-pathologist, and his original manner of attack may spell the popularity of his book, certainly he has added interest for the casual reader and student.

Practically all the pathological states of the brain and spinal cord are discussed, even if briefly so. Pathogenesis is in each case well handled, and the author's personal interpretations, if not always wholly acceptable, are stimulating; the gross descriptions are more satisfactorily treated than are the microscopic findings; the matter of stains and histoneurological technique is not discussed. The fact that the book is based on the study of 15,000 autopsies is evidence of the author's wide experience and opportunity for quantitative research.

The book is well illustrated, and some of the photographs are remarkably good. However, composite pictures such as Figure 114, illustrating possible lesions due to birth injury, are confusing and through their complexity are in danger of losing their graphic appeal to the student for whom they were probably intended. Figures 119 and 137, the author's own drawings to illustrate histological changes, are examples of a book-wide plan of illustration which could have been more favorably shown either by good photomicrographs or a simpler form of line drawing.

The spaces allotted to a discussion of trauma to the head, brain tumors, and degenerative and infectious brain disorders are proportionate to one another and to the rest of the book except for the spinal cord. The treatment of the spinal cord in general is too brief compared to the importance of cord disease, and the student may be impressed that cord pathology is not as common as it actually is, and that its manifestations are less dramatic than is actually the case. And here one might ask, why do texts treat of pathology of the central nervous system only? Why is the pathology of the peripheral nerves in this mechanical era with its frequent nerve injuries of so apparent little interest to the pathologist?

The author seems not to be impressed by the rôle of local vertebral osteomyelitis in the etiology of spinal epidural abscess, his explanation is the common one either by direct extension from a local soft tissue lesion (as furuncle) or by the metastatic route. Cranial osteomyelitic foci (as infected mastoids or sinuses, traumatic osteomyelitis) are described, however, as being a common cause of cranial extradural abscess. He deserves much credit for his remarks on syphilis of the central nervous system,

and he is obviously annoyed by the loose term "CNS lues." In his entire series of 15,000 autopsies only six gummas of the brain were found, and it is his opinion that if syphilis is present in the central nervous system it can be detected and the particular form of the disease can be named, without need of its being confused with other, equally common, diseases which also affect the nervous system.

This book has the distinct advantage of being easy to read, the subjects are well organized, it is lacking in detail, and it is relatively brief. For these reasons, as well as for the unexpected appendix of 'clinico-pathologic aphorisms,' it will no doubt appeal and be useful to the student and general practitioner alike. It is likely that most clinical neurologists and neurological surgeons require a more complete and detailed treatise.

JOHN MARTIN

THE knowledge and experience of the editors and twenty-six contributing authors of *The Practitioner's Library of Medicine and Surgery*,² are a guarantee of its completeness and accuracy. Until recent years public health activities have been concerned mainly with the health of aggregations of people by the safeguarding of water supplies, sewage, food, the quarantine against infectious diseases, etc. More recently, largely through the influence of the advances in immunology there has been a change in stress to the individual. This shift in emphasis together with the increasing trend in medicine toward prevention of disease as against treatment, demands of the practicing physician a greater participation in public health. The authors appreciate this change and the added responsibility it has placed on the practitioner of medicine. To this end in Part I, "Individual Hygiene" is presented in a very informative manner, with chapters on periodic health examinations, hygiene and nutrition, hygiene of clothing, exercise and rest, excretion, air and sunshine, cleanliness, sex hygiene and personal hygiene. Part II, Group Hygiene, Part III, Community Health, and Part IV, Prevention of Specific Diseases, treat adequately the community aspects of public health and also many individual applications. The book is exceptionally free from typographical errors, arrangement of the contents logical, and writing, printing, and make-up excellent. Alike practicing physicians and those specializing in preventive medicine will find it most interesting and valuable.

A. A. DAY.

OF INTEREST to the obstetrician and gynecologist, and particularly to those members of the medical profession who attempt its utilization and interpretation, should be *The Rabbit Test*³ by Anklesaria, a small volume of 161 pages which presents in a

¹ THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY Vol. 12—Preventive Medicine and Hygiene. New York and London: D Appleton-Century Co., Inc., 1937.

² THE RABBIT TEST, FOR THE DETECTION OF CHORIONIC TISSUE IN THE BODY AND THE DETERMINATION OF ITS PROLIFERATIVE ACTIVITY. By S. B. Anklesaria, M.D. (Bom.) With a foreword by Dr. Emil Novak. Bombay, India: Bombay Fort Printing Press, 1937. (Obtainable from H. K. Lewis & Co., Ltd., London.)

³ PATHOLOGY OF THE CENTRAL NERVOUS SYSTEM, a Study Based upon a Survey of Lesions Found in a Series of Fifteen Thousand Autopsies. By Cyril B. Courville, M.D. Mountain View, Calif.: Pacific Press Publishing Ass., 1937.

very complete manner all phases of this biologic test. The opening chapters provide a comprehensive background of such knowledge of obstetric and gynecologic endocrinology as is either necessary or available at the present stage of development. An extensive review of the literature incorporated throughout the volume serves to illustrate and emphasize the results obtained. Numerous case reports are included as the various phases of the test are discussed which adequately illustrate and support the conclusions formed. The pitfalls of erroneous interpretation due to the limitations of the test are constantly stressed by the author although it might be suggested that the respective advantages and disadvantages of the immature as opposed to the mature rabbit as the test animal have not been sufficiently emphasized. Experience has indicated that careful consideration of these factors permit the elimination of many addi-

tional sources of error. In the closing chapters the author presents a highly commendable personal contribution consisting of a technique for quantitative hormonal estimation for the differentiation between normal and abnormal chorionic development as encountered in hydatid mole and chorion epithelioma. The evidence presented indicates that the criteria suggested by the author regarding the interpretation of these determinations should reduce to a minimum the unnecessary evacuation of normal uterine contents and the removal by hysterectomy of uteri containing normal products of gestation as has so frequently occurred when haphazard dilution methods have been utilized. The author is to be commended for a very complete presentation of a difficult subject which will be of unlimited value to anyone interested in the problems involved.

PHILIP F. SCHNEIDER

BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

CUTANEOUS CANCER AND PRECANCER. A Practical Monograph. By George M. Mackee, M.D. and Anthony C. Cipollaro, M.D. New York: The American Journal of Cancer, 1937.

OXFORD MEDICAL PUBLICATIONS. THE DISSECTION AND STUDY OF THE SHEEP'S BRAIN AS AN INTRODUCTION TO THE STUDY OF THE HUMAN BRAIN. By James Wilkie, B.Sc. Foreword by Professor T. B. Johnston. London: Oxford University Press, 1937.

OXFORD MEDICAL PUBLICATIONS. TEXTBOOK OF GAS TROSCOPY. By Robert Henning. Translated by Harold W. Rodgers, F.R.C.S. London: Oxford University Press, 1937.

OXFORD MEDICAL PUBLICATIONS. MUIR AND RITCHIE'S MANUAL OF BACTERIOLOGY. Revised by Carl H. Brown, M.D., LL.D., D.P.H., F.R.S. and Thomas J. Mackie, M.D., D.P.H. London: Oxford University Press, 1937.

BENTLEY AND DRIVER'S TEXTBOOK OF PHARMACEUTICAL CHEMISTRY. Revised by John Edmund Driver, Ph.D., M.Sc. (Lond.), F.I.C. 3d ed. London: Oxford University Press, 1937.

THE ROLE OF CHEMOTAXIS IN BONE GROWTH. By A. P. Bertwistle, M.B., Ch.B., F.R.C.S. (Edin.). London: Henry Kimpton, 1937.

THE SCIENCE AND PRACTICE OF SURGERY. By W. H. C. Romanis, M.A., M.B., M.Ch. (Cantab.), F.R.C.S. (Eng.).

FRS (Edin.) and Philip H. Mitchiner, M.D., M.S. (Lond.), F.R.C.S. (Eng.), 6th ed. Vol. 1—General Surgery. Vol. 2—Regional Surgery. London: J. & A. Churchill Ltd., 1937.

IL CANCRO DELLA MAMMELLA. STUDIO ANATOMO-PATOLOGICO E CLINICO. By Giampaolo Coggi, Bologna: L. Cappelli, 1937.

ATLAS OF SKELETAL MATURATION. By T. Wingate Todd, M.B., Ch.B. (Manc.), F.R.C.S. (Eng.). St. Louis: The C. V. Mosby Co., 1937.

MEDICO-LEGAL ASPECTS OF THE RYKTON CASE. By John Glaister, M.D., D.Sc., Barrister at Law, and James Couper Brash, M.A., M.D., F.R.C.S. (Edin.). Baltimore: William Wood & Co., 1937.

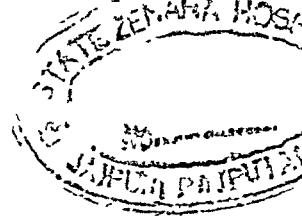
DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.), 6th ed. rev. Baltimore: William Wood & Co., 1937.

PAVLOV AND HIS SCHOOL. THE THEORY OF CONDITIONED REFLEXES. By Prof. Y. P. Frolov, M.D. New York: Oxford University Press, 1937.

FEVER THERAPY. ABSTRACTS AND DISCUSSIONS OF PAPERS AT THE FIRST INTERNATIONAL CONFERENCE ON FEVER THERAPY. Edited by the Members of the American Committee. New York: Paul B. Hoeber Inc., 1937.

MEGACOLON UND MEGACYSTIS. ENTSTEHUNG, ERKENNUNG UND BEHANDLUNG. By Dr. Hans Wolfgang Paessler. With foreword by Prof. Dr. Wilhelm Rieder. Leipzig: Johann Ambrosius Barth, 1938.

INNERE SEKRETION UND CHIRURGIE. By Hans Hanke. Berlin: Julius Springer, 1937.





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THE SURGEON AS A BIOLOGIST

J. P. LOCKHART-MUMMERY, F.R.C.S. (Eng.), London, England

TODAY surgery may be said to be truly international; it has no country and no language of its own, and the American College of Surgeons, with that insight which has always distinguished its founders, has, I consider, done more than any other single body of men to bring all nations and peoples into a common brotherhood for the furtherance of our science and craft and to foster that spirit which works for the benefit of all humanity, and not for any single section. One must hope that the day may yet dawn when, urged by the same lofty principles, the nations of the world will combine to ensure for human beings a stable political world where peace is more or less assured and is no longer a mere interval between successive wars. Science and medicine cannot progress or flourish unless there is security and peace between nations, and the same is true of all useful human enterprises and movements for betterment of the race.

The science of biology is the study of living organisms, the manner in which they arise, the way in which they function, and the methods by which they reproduce themselves. It includes such different subjects as botany, zoology, physiology, pathology, and genetics, and a biologist is one who studies living organisms and strives to discover the truths of life and living things, and in that respect every

doctor, who is anything more than a mere craftsman, may legitimately claim to be a biologist, since in his daily work he is constantly called upon to study and observe the most complicated and intricate of all living organisms, the human body.

We may take pride to ourselves that many of the greatest discoveries of the past in the biological field have been made by doctors as the direct result of their observations of the human body in the course of treating patients. I have only to mention Harvey's discovery of the circulation of the blood in the early part of the 17th century, Lister's discovery of the causes of suppuration and the way in which sepsis in wounds can be prevented, Jenner's observation that milk-maids did not contract small-pox and his deductions from those facts which led to the discovery of vaccinia, John Hunter and his intensive search for the fundamental causes of disease and injury, Cushing and Horsley's observations on the functioning of the human brain, and Banting's discovery of the cause of diabetes.

It may be said that every operation a surgeon performs is a biological experiment and affords, or may afford, an opportunity for the discovery of some new biological truth. It is, I think, often not realized by the pure laboratory research workers that unrivalled opportunities are afforded to the surgeon for direct observation of living human tissues, both in health and disease, and for the study of the

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manner in which such tissues react to trauma and other forms of damage

The surgeon habitually, as part of his daily work, performs vivisection upon the human body, and in that respect has an advantage over the pure research worker, who is necessarily confined to the vivisection of animals. It is true the surgeon cannot experiment in the strict sense, but he has great opportunities of observation and a great deal of our knowledge of living processes is founded upon the accumulated observations of surgeons while performing operations upon living subjects.

We are accustomed to distinguish between pure research and clinical research, but there is no hard and fast line to be drawn between them and the clinician, provided he has the true scientific mind, is as much a pure research worker as he who works in a laboratory. The one is indispensable to the other and the best results are obtained when the clinician and the laboratory investigator are working in close collaboration.

There is, it seems to me, a very real danger in these days that medicine may be too much divided into separate compartments. We have the physician, the surgeon, the pathologist, the pure research worker, and the biochemist, all doing their own work and often hardly aware of what is happening in each others' departments. This division of work into a number of different sections is necessary in these days, if we are to make rapid progress, and there can be no doubt is largely contributing to make medicine a true science but unless close touch is maintained between the different departments the individuals tend to become *over* specialized and too much like the machine minders of the mass production factory. The surgeon and the physician should do work in the laboratory and the pathologist, the physiologist, and the research worker should sometimes attend operations and see clinical work at the bedside. I have always made it my practice to attend in the laboratory of my hospital at least once a week and I know I have greatly benefited thereby. I am persuaded that the practice is a good one. The observations that are made in the operating theater and the laboratory are more correctly evaluated if they are frankly dis-

cussed between the surgeon and the pathologist. A fact which may to the latter appear of little importance may be of the utmost significance to the surgeon who knows its clinical bearing and vice versa.

But if the surgeon is to be a biologist in the scientific sense he must learn to make exact measurements. The essence of scientific observation is exact measurement. It has been said that doctors are not scientists because they cannot express their conclusions in figures. In the past this criticism was to a large extent true, morbidity was stated as the opinion of an eminent person unaccompanied by any kind of data, and was often accepted as fact, but in recent years a great deal has been done to obtain exact data in relation to diseased and abnormal states, and medicine is on the way to becoming an exact science where proof will take the place of opinion.

We can now estimate the state of the damaged heart in terms of the electrocardiograph, the condition of the kidneys in terms of the blood urea, and the water balance of the tissues in terms of the calcium content. It is now often possible to express pathological conditions in percentages and figures.

Neither the surgeon, nor the pathologist should ever cease to learn new facts or new interpretations of old facts. The art of healing has not yet reached any finality, nor is it likely to do so for a very long while. Surgeons have from time to time fallen into the error of believing that their craft had reached such a stage of perfection that little further improvement was possible.

Even that great surgeon of the seventeenth century, Ambrose Paré, fell into the common error of ceasing to be a humble student of nature and becoming too satisfied with what he had achieved, as is evident from this passage in the dedication of his work on surgery to King Henry the Third of France: "For God is my witness, and all good men know that I have now laboured fifty years with all care and pains in the illustration and amplification of Chirurgery and that I have so certainly touched the mark whereat I aimed that antiquity may seem to have nothing wherein it may exceed us, beside the glory of invention, nor posterity anything left but a

certain small hope to add some things, as it is easy to add to former inventions." Paré was undoubtedly the greatest surgeon of his age, but were it possible for him to come back to practice today, he would find that the only thing he knew would be how to reduce a dislocation and how to set a fracture, and even in this respect he would be unable to compete with the most junior house surgeon at one of our big hospitals

This quotation from Ambrose Paré shows how unwise it is for us ever to assume that what we regard as the great achievements in knowledge and practice of our own time are final or unsurpassable, or that we ourselves have learned all that we can. Nothing is ever final, nor can knowledge ever stand still. The true enquirer, and the true surgeon, must always keep a humble spirit, content to help forward to the best of his ability the practice of his craft in his own time and in the sure hope that those who come after him will find the foundations upon which they desire to build are firm and sure, and have not, as the result of his mistakes, been falsely laid. He must be ready to unlearn much that he has learned and start again from the beginning, not once, but many times.

The changes which have taken place in the practice of surgery even in the comparatively short period since I first became a medical student at Cambridge have been very considerable. Thirty years ago, once an operation had been decided upon, the surgeon proceeded to perform it without any further assistance than an anesthetist and a house surgeon. No preparatory treatment was deemed necessary and the surgeon was quite prepared for the fact that for many hours, sometimes days, after the operation his patient would be violently sick, due to the ether or chloroform, which were the only available anesthetics. But today the surgeon requires a regular team of assistants if he is to do first class work. Often elaborate tests have to be made requiring the assistance of skilled scientists, a physician's report on the functioning of the patient's various organs has to be obtained, biopsy specimens have to be reported upon by a skilled pathologist, and the surgeon has to rely upon a number of persons beside himself

to assist him in bringing the case to a successful conclusion; in other words, the best surgery now requires team work.

This is now generally realized and is a great tribute to the pioneer work of the Mayo brothers, who first instituted it. One of the results of this development is that much more elaborate equipment for hospitals has become a necessity and that operations cannot now be satisfactorily performed in the patient's own home. Another result is that operations have tended to become more expensive, but any extra expense is well worth the additional safety that is provided by modern team work and modern hospitals.

Admirable as this is, it has always seemed to me there is today a real danger that the young surgeon who is just starting his career may too readily believe that surgical operations can be performed *only* under circumstances where such services are available, that he may come so to rely upon the facilities which a modern up-to-date hospital, like those I have seen in this city, affords, that he will be unable to operate successfully under circumstances where they are not available. But it may well happen that he will not have the good fortune to become a surgeon to one of the great hospitals of this, or any other city, but may find himself in some out of the way part of this great continent, or some other continent, where he will be called upon to perform operations entirely without skilled assistants and with none of the facilities to which he is accustomed, and if he is the man he should be he will not be discouraged but will so improvise his equipment and reorganize his technique as to be able to deal successfully with the situation. Most of us who had to attend to the wounded during the last war had to learn this lesson, and on the whole, if the results were not as good as we had expected, they were not too bad.

Some years ago I had to go to Nepal, which lies between British India and Tibet, to operate upon the Maharajah of that State, and while I was there I was asked to do a number of operations under circumstances to which I was quite unaccustomed. There were no nurses at all, the patients just "stayed put." if I may use that expression, until I

came back, often several days later. They did not seem to have moved at all since I had last seen them, although no doubt they had been fed. The anesthetists were worse than untrained, they were definitely unsafe, even when giving chloroform, which was the only anesthetic they knew anything about. I managed, however, to perform a large number of operations with, I am thankful to say, excellent results.

While modern methods are a great improvement and are essential if we are to attain to the standard we have set ourselves, namely one hundred per cent success, a great deal of excellent work can nevertheless be attained without them. The best surgeon is not he who can get good results only when working as part of a team in a modern hospital, or who cannot make a diagnosis without a pathological report, but he who can adapt himself to the circumstances in which he finds himself and still make a diagnosis and operate successfully with the minimum of risk and postoperative discomfort compatible with the circumstances.

Every surgeon who is scientifically minded, and I have little use for the surgeon who is not so minded, must be content to try to add something to the sum of human knowledge. To be content to practice his craft just as he has been taught it and to leave it as he found it should not be enough. He should strive to add something for future generations.

It takes a long time to establish the truth of new biological discoveries and only those who are content to wait and are able to put up with constant discouragement and disappointment are worthy to call themselves biological explorers. New truths take time to become established and old customs and old ideas die slowly and with much difficulty, but, in the end, truth can never fail to succeed, and to find its proper place. It may be and often is delayed, but it cannot be entirely or permanently suppressed.

Today the surgeon is making more and more use of biological research to assist him in saving the lives of his patients, or in enabling him to avoid procedures which he knows may jeopardize his results. Our recently acquired knowledge of some of the facts with regard to

the water and calcium balance of the blood and tissues has proved of the utmost value in dealing with cases of severe intestinal obstruction and in avoiding complications after certain operations. We now have tests such as the "urea clearance test" (Van Slyke test) by which we can often estimate before operation the dangers to which our patient will be exposed and which enable us to so prepare him that the risk can be much diminished or avoided. Operative surgery is gradually becoming a science as well as a craft, and those of you who will be performing operations during the next 30 years will, if you make proper use of it, have at your disposal the means to reduce many of the risks of surgical procedures that are not available to us today.

At the beginning of this century postoperative surgical shock had taken the place of sepsis as the chief cause of death after surgical operations. A certain degree of shock was expected after all major surgical procedures and the notes of that time revealed it as the most common cause of postoperative mortality. Practically nothing was then known about the cause or physiology of the condition and the treatment was confined to keeping the patient warm and injecting strychnine in large doses. It is now quite obvious that many other conditions, not then known about, were either confused with cases of true shock, or were mixed up with it. Such conditions as dehydration, calcium deficiency, what is often called acidosis, and many other now well recognized complications, were at that time not distinguished from true shock.

Looking back upon my early days at the Queen's Hospital for Children, I remember many postoperative deaths among the children in my surgical wards that I now recognize as having been due to acidosis caused by the chloroform then used as an anesthetic, and which could easily have been prevented by the administration of sugar or alkalis, had we at that time known what to do.

The commonly accepted pre operative treatment at that time was to administer a smart purge to the patient the day before the operation and to starve him for 12 hours. After the operation water was given in teaspoonful doses and no food allowed for several days.

When we realize that as a result of the use of the anesthetics then in vogue severe vomiting was the rule rather than the exception after any operation, it only surprises me when I look back to those days that our mortality was not worse than it was, but even then our patients often insisted on recovering despite our efforts! The general principle of treatment in those days appears to me to have been that anything the patient desired *must* be bad for him and should, therefore, be withheld!

It was then that Dr. Crile first published his famous monographs describing the results of his research work into the causes of surgical shock. At about the same time I was carrying out research on the same subject in England, and in 1905 I had the honor of delivering the Hunterian Lectures at the Royal College of Surgeons in England on "The Cause and Prevention of Shock."

I was a follower of Dr. Crile's in that I believed exhaustion of the nerve cells controlling the vasomotor centers, from overstimulation by ascending sensory stimuli, was the primary and essential cause of the condition known as "surgical shock." For a time this theory held the field and was to a large degree accepted as the correct explanation of surgical shock, though it met with considerable opposition both here and in England. But in 1917 when my old schoolfellow, Sir Henry Dale, discovered histamine, opinion began to change. In 1919 when he and Laidlaw propounded the theory that surgical shock was due to a toxic agent (histamine) liberated by trauma of the tissues, opinion swung round to the belief that surgical shock resulted from chemical poisons circulating in the blood as the result of the trauma.

Whether the theory of exhaustion of the nerve centers put forward by Dr. Crile and myself over 30 years ago is correct or not is still unsettled, but I think you will agree with me that the value of any biological discovery must be considered in relation to the benefits to humanity that result: in fact this might be considered a useful "yard stick" for measuring the value of any advance in knowledge. Now, there can be no question that the theory of shock being due to exhaustion of the vasomotor centers led directly to the application of

methods in prevention and treatment which have in recent years almost entirely eliminated surgical shock as an operative risk. I can frankly say that I cannot recollect a single case of true surgical shock having come under my observation during the last 15 years, and that is not because surgical operations have become less drastic or less formidable than previously, for the reverse is the case.

Whether this theory of the exhaustion of the nerve centers is the correct one, or not, future biologists will no doubt eventually decide, but the benefits to humanity of the publication of the theory have already been reaped. It is interesting to observe in this connection that quite recently the biologists and physiologists have shown a tendency to swing over again to our original theory of nerve exhaustion.

No one has been able so far to detect any substance in the blood coming from a traumatized limb which will cause shock when injected into another animal. Also Simonart has shown experimentally that if the vessels of a traumatized limb are occluded prior to the trauma but the nerve supply left intact, a typical condition of shock develops, although there is no blood passing from the traumatized limb to the general circulation. It looks, therefore, as if the original theory of nerve exhaustion is in the main correct. In any case I feel sure that Dr. Crile, like myself, will be content to leave the truth to be established in the lap of time.

A new branch of biology which has recently engaged the attention of scientists throughout the world is destined, in my opinion, to have a profound influence upon medicine and surgery in the near future. I refer to the science of genetics, the means by which heredity works to transmit characteristics from the parent to the offspring. At first it may seem that this has little to do with the healing art, but it is generally recognized that it is as much the duty of doctors to prevent disease as to cure it and anything which will assist us to understand how diseased conditions arise, or are transmitted from one generation to another, will better equip us to combat them.

There is much yet to be discovered in the field of human genetics, but thanks largely to

the brilliant work of Morgan, de Vries, Muel-
ler, Loeb, Maud Slye and their co workers, a
great deal has already been discovered

In the science of genetics, which may be
defined as the manner in which hereditary
characteristics are transmitted from parent to
offspring, we have, I believe, found the key
which will open that door, so long closed to us,
behind which is to be found the explanation
of the cause of tumors. Ever since human
diseases began to be studied scientifically in-
stead of empirically the chief problem that
has intrigued everyone has been that of the
origin of tumors. A vast amount of time and
money has been spent during the last 25
years in attempting to elucidate this problem,
and, although no definite result has been
reached, the enquiry has been considerably
narrowed. We now know that tumors occur
in all vertebrate animals, that they are species
specific and cannot be transmitted from one
species of animal to another, that if left alone
they continue to grow indefinitely during the
life of the organism in which they arise and
that if completely removed they do not tend
to recur. We know that by selective breeding,
mice can be obtained that are predisposed
almost one hundred per cent to the formation
of spontaneous tumors, or are almost entirely
immune to the development of such tumors.

The first suggestion that tumors might be
explained by a change or mutation in the
nucleus of a somatic cell was made by Boveri
in 1914. He put forward the theory that a
mutation of the chromosomes in a somatic
cell was the cause of tumors, but when it was
found that the chromosomes in the nuclei of
human tumors were normal both in numbers
and arrangement this theory had to be aban-
doned, though it may be true of some of the
tumors of plants. Bauer had also suggested
that a mutation of the nuclear elements in a
somatic cell might be the cause of tumor
formation (1928). In 1932 I published the
theory that tumors are due to a mutation of
the genes in a somatic cell for excessive repro-
duction.

This theory has the merit of offering a satis-
factory explanation of the known facts about
tumors which no other theory has hitherto
achieved. But in order to establish a theory

it is necessary to bring forward experimental
proof, and at present this is not possible.
The genes are, and must always remain,
invisible to the human eye and gene mutation
cannot ever be visible. So far no one has suc-
ceeded in devising any form of experiment
that will prove that a tumor results from a
gene mutation in a somatic cell, and at present
the theory remains as a logical deduction from
known facts of the probable causes which re-
sult in the formation of a tumor.

A logical conclusion which explains the
known facts, even if it is no more than a stated
opinion, promotes the progress of scientific
knowledge even if it should subsequently
prove to be wrong. At present this theory
relies on negative rather than positive evi-
dence, but all the findings of Maud Slye and
others on genetic factors in mouse tumors
seem to support it.

The remarkable observation made by
McFarland and Meade on tumors in uniovular
twins seems to me strongly to support the
theory. They collected 20 reports on tumors
occurring in homologous, or uniovular, twins.
In every case the tumor was present in both
twins at the same time. The tumor was of the
same type and occurred in the same organ.
In one case both twins developed sarcoma of
the right testicle at the same age and in an-
other case both twins at the same age devel-
oped duct carcinoma of the right breast.
Since uniovular twins result from the division
of the original fertilized ovum into two
halves each of which develops into a com-
plete individual it must follow that they have
an exactly identical genetic constitution.

It seems to me that nature has here per-
formed an experiment for us which proves
that tumors are due to some genetic change
in the nuclei of certain somatic cells. We
know that variations which are permanent
and irreversible result from gene mutations
in the germ cells, and that by this proc-
ess working during millions of years, the
various species and varieties of living organ-
isms which inhabit this earth have been slowly
evolved. It seems reasonable to conclude that
similar gene mutations can also occur in the
somatic cells of the adult individual. If such
a change takes place for increased rate of

growth in a somatic cell then since the change must be permanent and irreversible the ultimate result must be the development of a tumor.

An obvious argument against this theory is that if mutations occur in somatic cells there should be many examples of this, apart from tumors, since it is unreasonable to suppose that only mutations occur which result in excessive growth. But mutations which result in any other change will never be seen. A somatic cell is not like a germ cell in having numerous progeny; when it dies it is only replaced by another single cell, and if it underwent a mutation to become black instead of white, since only a single cell would be affected, no obvious result would appear. It is only when an increased rate of reproduction is included in the mutations that any result can become obvious.

This theory, while it appears to explain the origin of tumors, does not seem to afford any easy solution to that much greater and more important problem of how to prevent or cure tumors in human beings, but knowledge is strength and human experience seems to show that when the cause of a disease is known it has generally led to the discovery of some means of prevention or cure, and it may well be that tumors will prove no exception.

I hope that my oration this evening has demonstrated that the surgeon should also be a biologist, that he should not be satisfied merely to practice his craft with dexterity and success, but should strive to make use of his unrivalled opportunities for the observation of human processes in health and disease, to learn new truths, however apparently un-

important, which when checked and rechecked may in the course of time add to the sum of human knowledge and lead in the future to better and surer means of alleviating human suffering.

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TREATMENT OF PEPTIC ULCER—INDICATIONS FOR SURGERY

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SINCE the chairman of your Board of Regents has insisted that I a mere physician, speak to you, a group of surgeons, on the indications for surgery in peptic ulcer, although I assured him I had nothing new or original to contribute to that time honored subject, I am constrained to believe that he feels that the physician's as well as the surgeon's opinion on when the patient with ulcer should undergo operation, is important. Certainly it is true that in most instances it is the physician who first sees the patient with ulcer, makes the diagnosis, and decides whether or not to call in the surgeon. Moreover, if the surgeon is called in and operates, the physician will still have to care for the patient for the rest of his life because surgery (8, 11) usually does not cure the patient with ulcer any more than does medicine. As a physician approaching the problem of indications for operation in peptic ulcer I may ask, "What can the surgeon do for my patient which I cannot do, and what are the risks, complications, and sequelae of the kinds of treatment which he can furnish? How permanent is the relief he can give?" If answers to these can be found the problem raised by the title will be solved.

The etiology of peptic ulcer (12, 17, 20, 28, 36, 37) is unknown, nor does speculation as to etiology give any aid at the present time to choice of treatment. For our immediate purpose it is only necessary to accept as fact that ulcerations commonly occur in stomach and duodenum, occasionally in the esophagus and in the small bowel, as a result of surgery, and that they produce certain typical, or some times atypical, symptom pictures and run certain characteristic clinical courses. One of the most important features of a peptic ulcer is that although it tends to heal, it also tends to

recur or become chronic (11). As either physicians or surgeons, we may relieve the symptoms of ulcer, or alter its course. We have yet to learn how to remove the cause of the disease.

Before planning treatment in ulcer it is necessary to determine beyond peradventure whether an ulcer be truly present, and, if so, of what variety. In the diagnosis of ulcer careful history taking, expert roentgenography, and of late gastroscopy, are all important. Physical examination usually yields comparatively little direct evidence, and analysis of gastric contents is less important than it used to be because other procedures give more significant information. On the whole the diagnosis of ulcer is rather accurate (40). Not only is it important to discover the presence of ulcer, but also its location because location conditions its course, and is importantly related to indications for treatment.

Gastroscopy rates special mention. It is not a substitute for x ray, rather an adjunct, but, by means of the direct view it affords, a more accurate impression of the nature of a lesion can often be obtained than is possible in any other way. It is of vast importance in determining the source of hemorrhage in certain cases, of gastritis, for example, in which there may be bleeding approaching in magnitude that in ulcer. The introduction in 1932 of the Wolff Schandler flexible gastroscope (34) revolutionized gastroscopy, because it converted a dangerous procedure into one which is quite safe provided certain simple precautions are taken, and one not attended by great discomfort. In the hands of Benedict (6, 7) at Massachusetts General Hospital who, I think, was the first to use the instrument in this country, gastroscopy has become an important aid to our diagnostic equipment. Edwards, in England has reported results quite similar to Benedict's.

The differential diagnosis between ulcer and cancer is the most important, in this field which we have to make. First symptoms com-

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ing on acutely in middle life, or later, of course strongly favor cancer, although even so they can be due to ulcer. More often the problem is not so much one of distinguishing between ulcer and cancer as in determining whether the patient with known chronic ulcer also has cancer. The gastroscope gives important aid in settling this question.

The location of the lesion is of vast importance in the cancer question. A lesion which can be clearly placed in the duodenum is almost certainly not carcinomatous. A lesion of the greater curvature of the stomach is almost certainly malignant; so too is one high in the fundus. An ulcer in the prepyloric region of the stomach or upon the posterior wall is to be looked upon as cancerous until proved not to be. Lesser curvature ulcers are usually not malignant, but even they may be. In the case of lesser curvature, prepyloric or posterior wall gastric ulcers not definitely cancerous by x-ray and gastroscopy, and with constitutional symptoms suggestive of cancer lacking, it may be permissible to observe the effect of a short course of strict medical regimen, including rest in bed, upon symptoms and x-ray and gastroscopic findings (19). If, after not more than a month of such treatment, cessation of symptoms and unmistakable evidence of healing by x-ray are not obtained, then exploration without further delay should be recommended. If, on the other hand, convincing evidence of healing is obtained, expectant treatment may be carried further, but even then re-examination by x-ray should be made at rather frequent intervals. Exploration should be urged at any time when healing is not progressing.

Having made a diagnosis of ulcer and determined its location and ruled out cancer, to plan treatment intelligently it next becomes necessary to consider the following questions: Is the ulcer acute or chronic? Is it penetrating or perforating? Is it bleeding? Is it causing obstruction? In brief, is it simple or complicated? Upon the answers to these questions and upon location of the lesion will rest the decision of whether the given patient is to be treated by medicine alone or by a combination of medicine and surgery.

There is theoretical ground for claiming that all cases of peptic ulcer should be treated

surgically, that the surgeon can remove *in toto* all the ulcer bearing regions, and that only in this way can the disease be truly cured. The actual results of surgery thus far do not justify any such position. The statistics available in the literature indicate that the results in large series of medical treatment alone or medical plus surgical are not very different (11, 25, 40). It also is evident that the risk of operation is far from negligible.

This being true, it seems fair to say that aside from the occasional diagnostic necessity of exploration, which I have mentioned, surgery is indicated in peptic ulcer only for certain complications and for resistance to medical treatment (11, 17, 26), or for failure of previous surgery, nor is it clear that it is always indicated even then. The experience at the Massachusetts General Hospital indicates that about 10 per cent of all patients with duodenal ulcer ultimately come to surgery, but that 30 to 40 per cent of those with gastric ulcer come to operation. We can distinguish perhaps between certain absolute indications for surgery and others which are debatable.

The most absolute and urgent indication for operation is perforation. Although patients on occasion have undoubtedly survived perforation without surgery, the physician's job after making, or indeed suspecting, the diagnosis of perforation is to send at once for the surgeon. It is generally agreed that the prognosis gets steadily worse as time elapses; therefore one can say that the longer the physician remains inactive in such a case the more subject to criticism he becomes (32).

The operation to be done has the immediate purpose of closing the perforation and of saving the patient from death from peritonitis. There are some who advise going further at the same time and performing an operation designed to modify the course of the ulcer as well as simply to close the hole. Routine gastro-enterostomy, for example, with perforation closure, has been advocated, and even routine partial gastrectomy. At the Massachusetts General Hospital most of us agree emphatically with Graham, with Guthrie and Sharer, and with others (33), that to subject a patient in as imminent danger of death from

shock as is one with a perforated peptic ulcer, to the hazard of more than the minimum surgery necessary to correct the acute situation, is not wise treatment. Only the double complication of perforation and marked obstruction should justify more than simple closure. The preparation of the patient with perforation must be rapid but thorough. Transfusion to correct or to prevent shock is often indicated. The imminence of shock depends upon the time elapsing between perforation and operation, and upon the condition of the patient prior to the perforation. If operation is carried out within a few hours of perforation, because of the relatively sterile nature of the material spilled into the peritoneal cavity, drainage is usually unnecessary. It is very desirable to avoid drainage if possible, because the adhesive process, which it will surely set up, greatly increases the likelihood of obstruction later (18). In patients under care for chronic ulcer, it should be possible to minimize the occurrence of perforation. By strict attendance to the nature of symptoms and x-ray and gastroscopic evidence, one may detect and deal with penetration before it results in perforation rather than after.

Let us next consider the complication of hemorrhage. The indications for operation here can by no means be settled as easily as in the complication of perforation. Surgery is always indicated in perforation unless the patient be so near moribund that there is no hope of saving him. The only debate concerning indications for surgery in perforation has to do with how extensive the surgical procedure should be. In the case of hemorrhage not only is there difference of opinion as to when and what operation is to be done, but also whether operation is indicated at all. Perusal of the papers of Allen, Gordon Taylor, Tidy (39), Finsterer, Graham Hurst, Hinton, Goldman, Meulengracht Schudt and Woldman will give the reader a vivid impression of the divergence of opinion as to how hemorrhage from peptic ulcer should be treated. To arrive at a reasonable solution of the problem it is necessary to recognize that hemorrhage occurs under a variety of circumstances having different therapeutic significance. There are large exsanguinating hemorrhages there

are small ones carrying little risk. There are first hemorrhages and recurrent hemorrhages. There are hemorrhages in young persons and in old. All these factors have to be taken into consideration in planning treatment.

It is the opinion of Allen, Jones, and others at the Massachusetts General Hospital, that the factor of age has not been sufficiently stressed. First hemorrhages from peptic ulcer in persons under 50, even though massive rarely cause death. It seems to us very doubtful if operation during hemorrhage is indicated in such cases. Nor does it seem to us that subsequent operation in the case of first hemorrhage done for the purpose of preventing further hemorrhage is rational. There is a fair chance that the patient will never have another hemorrhage, even if not operated upon, and there is no guarantee that he will not have one again if operation is done.

In the treatment of massive hemorrhage from peptic ulcer whether first or recurrent, one of the most important therapeutic measures is the slow drip transfusion (27). Transfusion is of prime importance, not only in restoring blood volume and hemoglobin concentration during hemorrhage, but also in shortening the convalescence from blood loss afterward. The drip method makes it possible to give a maximum amount of blood with a minimum risk of increasing hemorrhage by raising blood pressure.

In persons past 50 the problem is different. In them the chance of death from an exsanguinating hemorrhage is much greater. Since if checking of bleeding by surgery is to be life saving it must be done early, it has been our policy to advise operation in patients past 50 with severe hemorrhage who show no improvement with drip transfusion in from 12 to 24 hours. We believe that although this course is hazardous it gives the patients in question the best break possible. In advising operation in any bleeding case the physician should recognize that it is difficult surgery. Hemostasis in either stomach or posterior wall of the duodenum which is where most big duodenal hemorrhages come from requires a thorough knowledge of the source of the blood supply to the region and how it can be reached outside the inflamed area.

Recurrence of hemorrhage also increases the indication for surgery. As the mortality from hemorrhage rises with age, so too it does with each recurrence (2, 15). We should prefer to have operation done after hemorrhage has ceased, rather than during, although on rare occasions one might be forced to the latter. Even in persons under 40 we should favor surgical intervention if the patient had had several large hemorrhages. If it were known that the ulcer was a posterior wall duodenal, the indications for operation would be especially great. The operation of choice in patients who have bled repeatedly from ulcer is probably some sort of resection (5, 13, 17, 21). Gastro-enterostomy offers relatively little because hemorrhages are about as frequent after it as without, either from the original ulcer or a subsequently forming gastrojejunal one.

Pyloric obstruction when permanent, that is to say, not due to temporary causes such as spasm or edema, is a strong indication for surgery—whether gastro-enterostomy or gastric resection is for the surgeon to decide. It should be recalled that the patient with obstruction is often a very poor operative risk on account of the interference with nutrition which he has sustained (4, 20, 23, 24, 31, 36). He may be short of vitamins, glycogen, protein, and salts. His plasma protein may be dangerously low. Prior to operation it is very essential that every effort be made to correct any such faults. A high vitamin intake is indicated, and to restore low plasma protein transfusion is the most effective procedure. The preparation for operation in these cases is quite as important as the operation itself. In a few very malnourished patients a jejunostomy for feeding may be desirable before the surgical attack is launched at the obstruction.

Finally we come to the question of indications for surgery in cases when adequate medical treatment has failed to give satisfactory relief. I may say also at this point that adequate medical treatment is not a matter of dietary regulation and rest alone. The psychic state of the patient with ulcer, as physicians and psychiatrists have found out, is of great importance (9). Peace of mind promotes peace and healing in a peptic ulcer perhaps more than any other factor. Persons who work un-

der strain, as for example surgeons, often have ulcers, and the more their jobs harass them the more their ulcers plague them with symptoms. Cases resistant to medical treatment will include many of the posterior wall duodenal ulcers which have become penetrating and involved neighboring structures. When this has happened, and its happening may be indicated by change in character and severity of symptoms, operation is undoubtedly indicated. What operation should be done has to be settled in the individual case (14, 26, 38). Whereas gastro-enterostomy in duodenal ulcer gives immediate relief to symptoms in many cases, it is far from ideal because of the frequency, perhaps 15 per cent of cases, in which it is followed by jejunal or gastrojejunal ulcer. It is particularly unsuitable in persons with hyperacidity and hypersecretion, and in those who have no pyloric obstruction. In cases in which gastro-enterostomy has been done, sustained and thorough supervision is indicated in order that postoperative ulceration can be detected early, as both hemorrhage and perforation not infrequently result from it (41). When jejunal or gastrojejunal ulcer is established, further operative closure of the gastro-enterostomy combined with such resection as is indicated becomes necessary.

Lesser curvature gastric ulcer will also sometimes fall in the group in which surgery must be done for intractability. The operation of choice in these is undoubtedly resection (partial gastrectomy), but occasionally in older patients, in highly weakened states, prudence demands the election of gastro-enterostomy instead.

CONCLUSIONS

In conclusion I will give as my opinion that all patients with peptic ulcer must be treated medically from the time the diagnosis is made until the end of their lives; that in addition, for certain complications of ulcer, surgical treatment will have to be employed.

The absolute indications for surgery are in the treatment of the complications of perforation and organic obstruction and to rule out cancer. The indications for operation about which opinion differs most greatly are those concerning hemorrhage. Personally, I shall accept the view that operation should be

shock as is one with a perforated peptic ulcer, to the hazard of more than the minimum surgery necessary to correct the acute situation, is not wise treatment. Only the double complication of perforation and marked obstruction should justify more than simple closure. The preparation of the patient with perforation must be rapid but thorough. Transfusion to correct or to prevent shock is often indicated. The imminence of shock depends upon the time elapsing between perforation and operation, and upon the condition of the patient prior to the perforation. If operation is carried out within a few hours of perforation, because of the relatively sterile nature of the material spilled into the peritoneal cavity, drainage is usually unnecessary. It is very desirable to avoid drainage if possible, because the adhesive process, which it will surely set up, greatly increases the likelihood of obstruction later (18). In patients under care for chronic ulcer it should be possible to minimize the occurrence of perforation. By strict attendance to the nature of symptoms and x ray and gastroscopic evidence, one may detect and deal with penetration before it results in perforation, rather than after.

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TECHNICAL SURGICAL PROCEDURES FOR GASTRIC AND DUODENAL ULCER

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THE honor which you have conferred in asking that we present our experience in the operative treatment of peptic ulcer is deeply appreciated. Our remarks are based upon the cases studied and patients operated upon from July 1, 1929, to September 1, 1937, on the First Surgical Division of the Toronto General Hospital.

Dr Means has presented to you the problems involved in the treatment of individuals with ulcer. He has also outlined the indications for surgical therapy. Today there is no fundamental disagreement between the physician and surgeon in the management of patients suffering from peptic ulcer. Surgical procedures have no place in the treatment of simple duodenal ulcer, and should be carried out for gastric ulcer only after adequate non-operative therapy. Operation, therefore, becomes necessary only in dealing with the complications of perforation, obstruction, penetration, and recurring hemorrhage. It is necessary to follow only a few patients suffering from the complications of an ill-advised, badly chosen, or technically faulty operative procedure, to be impressed with the great responsibility the surgeon must assume in advising an operation for gastric or duodenal ulcer.

The patient who accepts operation expects. (1) recovery from the operation; (2) relief from the symptoms, (3) security against recurrence of the disability; (4) restored economic efficiency.

In order to achieve this desired result, the surgeon, in determining the correct operative procedure, must take into consideration: (1) the site of the ulcer, (2) the character of the pathological lesion; (3) the associated physiological disturbances; (4) the resultant biochemical disturbances, (5) the age of the patient.

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Presented before the Clinical Congress of the American College of Surgeons, October 25-29, 1937.

1. *The site of the ulcer.* The site of the ulcer has a definite bearing on the operative procedure. The term "peptic ulcer" we believe to be bad. It is not used in our department. It presupposes a known cause of ulcer. It infers that gastric and duodenal ulcer are similar diseases. We believe much harm, confusion, and disastrous therapy have resulted from considering these 2 lesions as a single disease entity. We believe that in all cases we should speak of a duodenal ulcer or of a gastric ulcer, and discard entirely the term "peptic ulcer."

The difficulty of excluding malignancy in all gastric ulcers is well recognized. We have no interest in the debate as to whether a gastric ulcer becomes malignant or not. We are very greatly concerned in attempting to determine if the ulcer be malignant *now*. Such a problem does not arise in duodenal ulcer. If the lesser curvature of the stomach be divided by the incisura, our experience has shown that an ulcer situated proximal to this point is much less likely to be malignant than one situated between the incisura and the gastroduodenal junction.

In the duodenum, an anterior wall ulcer may produce severe symptoms, and be the seat of an acute perforation. If, however, the patient suffers from massive hemorrhage, we must realize that this anterior wall ulcer cannot be the source, but must be accompanied by a posterior wall ulcer. A posterior wall duodenal ulcer may be present with no anterior wall ulcer. Such an ulcer may produce no symptoms except recurring massive hemorrhage, or such symptoms as would result from a slow perforation, with the development of a peri-duodenal abscess. We have studied a series of posterior wall duodenal ulcers occupying the descending limb of the duodenum just proximal to the ampulla of Vater. Such have not given symptoms which enabled us to arrive at the diagnosis of duodenal ulcer. In

limited to patients bleeding after 50 or those having repeated hemorrhages

Resistance to medical treatment, or intractability, is a rather weighty indication for surgery, but a patient should not be branded as resistant to medical treatment until the latter has been adequate. The surgical problem in resistant cases is not so much one of whether surgery is indicated, but of what operation is best suited to the individual patient's needs. In general, some sort of resection is probably to be preferred to short circuiting procedures.

Finally, I should like to urge the closest possible co-operation between physician and surgeon in these matters. The physician should not be dismissed when the surgeon is called; he should remain in full partnership with the surgeon, both in preparation for operation and after care, and he should remain in charge of patient after the surgeon is finished with him.

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there is an increase in the units of free hydrochloric acid in the stomach. The degree of hypersecretion, and the increase of free hydrochloric acid, are, in most instances, in inverse ratio to the patient's age. Thus the control of ulceration in the young individual presents a much more difficult problem, not only to the physician, but also to the surgeon, than if the patient were elderly. In the instance in which a pyloric obstruction from scar has resulted in an atrophy of the gastric glands, there is a decrease in the units of free hydrochloric acid, whereas in the pyloric obstruction due to edema, the very activity of the ulcer resulting in the edema is accompanied by hypermotility and hypersecretion, and this means an increase in the free hydrochloric acid in the stomach.

As a result of pyloric obstruction, or pain associated with the intake of food, or a restricted intake because of the dietetic regimen, various biochemical disturbances are present. Vomiting accompanying pyloric obstruction is an outstanding symptom, and the loss of body fluids or salts results in a disturbance of the acid base balance of the individual, indeed, may even result in tetany and coma. Pain or restricted diet may result in undernourishment, or secondary anemia. Restriction of physical activity results in loss of general muscle tone. Ravdin has pointed out that such biochemical upsets may be accompanied by a decrease in the serum protein.

5 *Age of the patient* From the foregoing it is obvious that whenever possible operation should be avoided in the young individual. When, however, it becomes imperative, it should be a radical procedure. In the older patient, a more conservative operation of the indirect type is more often indicated. In a series of patients followed by MacFarlane who were operated upon within 2 years of the onset of symptoms, 46 per cent had an unsatisfactory result. Most of these patients were operated upon by an indirect procedure, before self-discipline was attained. The results eloquently confirm the wisdom of our present attitude.

An operation carried out without the recognition and correction of the above disturbances leads but to disaster. Therefore any

operative procedure for a gastric or duodenal ulcer must: (1) result in a decrease in the hydrochloric acid in the stomach; (2) establish efficient gastric emptying, with freedom from spasm in the stomach or duodenum; (3) be accompanied by excision of the gastric ulcer; (4) be associated with ligation of the blood supply of the duodenum in patients suffering from massive hemorrhage from a duodenal ulcer.

If operation be undertaken for a persistent and uncontrolled gastric ulcer, believing as we do that all gastric ulcers must be excised, we must choose between a local excision with the knife or cautery, with or without an associated gastro-enterostomy, or the more radical procedure of partial gastrectomy. In our experience all operations for a gastric ulcer other than partial gastrectomy have been so frequently followed by unfortunate post-operative sequelæ, that we have abandoned them. It is possible to do a gastric resection and resect any gastric ulcer. The principle of leaving undisturbed the ulcer base, which may be on the liver or pancreas, has made this possible. We would suggest that unless the ulcer be removed, the patient is better without operation. Many clinicians will cite cases in which a simple gastro-enterostomy has cured a gastric ulcer. May we suggest that were such patients put to bed on a proper diet and treated by means of the indwelling duodenal tube, as advised by Cleaver, such ulcers would heal without the surgeon's help. The medical regimen for gastric ulcer as outlined by Cleaver in our hospital is so efficient that operation for an uncontrolled gastric ulcer is rarely necessary. Cleaver's regimen consists in the introduction of a duodenal tube, which is proved radiographically to lie in the duodenum. No food or fluid is given by mouth, but through this tube adequate nourishment and fluids are introduced, and the stomach is thus placed at rest. Roentgenograms are made at the end of 3 weeks' treatment. If the ulcer is smaller, a further 3 weeks' treatment is given. If at the end of 6 weeks the ulcer is not healed, operation is advised. If the ulcer be healed at the end of 6 weeks, further roentgenograms are taken after another 3 weeks. A recurrence at this

over half the cases, because of the location of the ulcer, x ray studies have failed to reveal their presence. Such have been recognized only after an exploratory laparotomy under taken for persistent abdominal pain, or recurring hematemesis. We have termed such ulcers *duodenal ulcer occulta*.

2 The character of the pathological lesion

The local lesion has a definite bearing on the surgical procedure in the individual case. An acute perforation may occur in an acute or chronic ulcer. In either case, simple closure of the perforation will deal adequately with the emergency, and thus discharge the surgeon's sole responsibility under such circumstances. A posterior wall duodenal ulcer by penetration may invade the pancreaticoduodenal artery, or one of its branches. Such a lesion, in our experience, has been present in cases of massive hemorrhage. Indeed, the common duct may be invaded and an infective cholangitis result because of the direct communication of the duodenum with the common bile duct through the infected ulcer base (Fig 1). A gastric or a duodenal ulcer not uncommonly invades the liver or pancreas or both. In such ulcers, as their removal is desirable if operation be undertaken, our experience has taught us that leaving the ulcer base undis turbed has made the procedure more safe and has permitted removal of the pathological lesion in cases in which, if the base itself had to be removed, the attempt would have had to be abandoned. The pathological change about a duodenal ulcer may result in obstruction with the associated phenomena. The obstructing factor may be scar or edema from the inflammatory reaction about an active ulcer. It is of the greatest importance that we differentiate these two factors. The former has been progressive over a long period, and is accompanied by an atrophy of the gastric glands. The latter is of recent onset, is not accompanied by any change in the gastric glands, and continuous gastric drainage for 7 to 10 days with an indwelling duodenal tube results in the disappearance of the obstruction. With both sources of obstruction there is edema in the gastric wall. The stomach is large, and, in the scar obstruction, often atonic.

3 *The physiological disturbances* Such disturbances associated with an active duodenal ulcer are hyperperistalsis and increased gastric secretion, together with spasm in the stomach or duodenum. In an active gastric ulcer which has not penetrated all the muscle coats, there is demonstrated radiographically an evidence of persistent spasm. This is represented by a deep contraction in the greater curvature immediately opposite the crater in the lesser curvature (Fig 2). If, however, the ulcer has penetrated all the coats of the stomach, there is no such spasm but a large defect on the lesser curvature (Fig 3).

In a recent visit to Bergland's Clinic in St Erik's Hospital, Stockholm, we were shown a pitfall in the interpretation from x ray studies of the large penetrating ulcer. In the case presented, such was the diagnosis radiographically, but with the gastroscope there was only a small ulcer in the mucosa. The contraction in the stomach wall was limited to the muscularis mucosa, and gave a radiological shadow which could only be interpreted as a deep ulcer crater penetrating all coats. That the muscularis mucosa contracts independently of the muscle wall of the stomach as suggested by Forsell, has been definitely proved by the unpublished work of S D Gordon in our department. This serves to put the surgeon on guard before advising operative procedures largely on x ray evidence. It also explains why bed rest in many instances results in the almost incredibly rapid healing of what appears to be a large penetrating lesser curvature ulcer. In duodenal ulcer the work of Wilson has shown that spasm of the duodenal cap is present during pain. The gastric hypersecretion is of importance to the surgeon in so far as it means an increase in the units of free hydrochloric acid. While the cause of ulcer is unknown it is agreed that an excess of free hydrochloric acid is an important factor in the persistence of the ulceration.

4 *The biochemical disturbances* The biochemical disturbances associated with ulcer are of great importance in first determining the type of preoperative preparation and, second, in selecting the proper operative procedure. As a result of the hypersecretion,

the ulcer and thus has lessened local infection and the likelihood of peritonitis.

Two patients died of pneumonia, and 1 patient returned 3 months later with an abscess about the duodenal stump. Following drainage of the abscess, a duodenal fistula developed, which added to the infection and was responsible for death.

This mortality is almost identical with our incidence in gastric resection for gastric carcinoma. We submit that while these patients have not carcinoma, they are equally crippled, and, having exhausted all other forms of treatment, are justified in accepting this risk, as, if they survive a radical gastrectomy, they can look forward to good health, as we have no case of stomal ulcer in our series which followed a primary gastric resection for benign gastric ulcer.

The patient suffering from a *scar stenosis at the pylorus* who has never suffered a massive hemorrhage, presents the easiest problem. The long duration of the disease results in atrophy of the gastric glands, with a low free hydrochloric acid content in the stomach. The problem in such a patient is simply the establishment of normal gastric emptying. Hence any mechanical procedure of the indirect type will accomplish this and be followed by a good clinical result. A posterior gastro-enterostomy or a Finney pyloroplasty we have found most suitable. A Judd pyloroplasty or a gastroduodenostomy, as suggested by Wilkie, have given good results in the hands of many surgeons, but in our series we have had such an incidence of unfortunate sequelæ that we have discarded them. Where *recurring hemorrhage* from a duodenal ulcer has been present, ligation of the blood supply of the duodenum is essential to prevent further catastrophe. Thus some type of gastric resection becomes necessary.

We have still to consider 3 groups of patients suffering from duodenal ulcer who must accept surgical therapy. One group is represented by patients most often over 50 years of age with a low free hydrochloric acid content in the stomach. Hyperperistalsis is not marked. No massive hemorrhage has occurred, and no pyloric obstruction is present. Persistent pain is the outstanding symptom,



Fig 1 Case No 036036. Hepatic and common bile ducts outlined by barium during the course of a barium meal examination. The lesion was a posterior wall duodenal ulcer which had perforated into the common bile duct.

and it is unrelieved by food, but may be temporarily relieved by recumbency. The second group presents identical symptoms, but with the following difference: they are most often under 50 years of age. There is a high degree of free hydrochloric acid in the stomach, and gastric peristalsis is markedly increased. The third group suffer from duodenal ulcer occulta in the posterior wall of the descending limb of the duodenum. In the 3 groups, the local lesion is a penetrating posterior wall duodenal ulcer, with marked peri-duodenitis. In the first of the above groups we believe that a Finney pyloroplasty will be followed by a result which will fulfill the patient's demands. In the small series of 15 cases which we have followed after this procedure, we have seen happy results. If, however, any undesirable postoperative sequelæ should follow such a procedure, we have not destroyed our anatomical bridges, and subsequent surgical procedures may be carried out with safety. If, however, the ulcer penetrates the common bile duct, the passage of gastric content must be entirely diverted by a gastric resection.

The second group, comprising the younger

date demands operation. In this way one is able to differentiate between the malignant and the non malignant gastric ulcer with greater security than we had previously attained. If at the end of the first 3 weeks' treatment there is not definite evidence of improvement, it is presumed that we are dealing with a malignant ulcer. On the other hand, as Cleaver has shown with this treatment a malignant ulcer may be healed to such a degree that no radiographic evidence of its presence can be demonstrated. Such a fact leads to the necessity of examining patients with the x ray not longer than 6 weeks after the ulcer is healed by this treatment. In Cleaver's series, over a long period there is only one case in which a malignant ulcer was treated as a benign gastric ulcer. There is just one exception to deferring operation longer than 3 weeks after the indwelling tube has shown improvement in the ulcer. This exception is in a patient whose first symptoms occurred after 60 years of age. We have so far failed to find a benign gastric ulcer which has not been accompanied by clinical evidence of its presence before 60 years of age. In other words, we believe that all gastric ulcers which make their appearance after 60 years of age are malignant, and the patient should be advised to have a gastric resection as soon as adequate preoperative preparation permits. It becomes obvious, therefore, that all gastric ulcers which we see are first treated by means of an indwelling duodenal tube. Even in those cases in which operation subsequently must be undertaken, this treatment is of the utmost advantage, as it results in disappearance of the edema in the gastric wall about the

ulcer, thus permitting a more efficient and safe anastomosis.

Table I shows the detail of the small group of patients operated upon for gastric ulcer.

Several worthy observations may be made in regard to this group. The total number of patients who submitted to operation during this period of time is very small, and forcefully emphasizes the efficacy of Cleaver's method of non-operative therapy. The patients accepted for operation failed to respond to the treatment, or the ulcer recurred soon after they resumed the responsibilities of life. The reason tube treatment failed in these cases is explained by the extent of the local pathological lesion, and in 8, or 22 per cent of the cases, the patients had an associated organic hour glass. In 13, or 33 per cent, the ulcer base was left *in situ* because it involved contiguous structures, notably the liver or pancreas.

It thus becomes obvious that the patient with gastric ulcer whom we accept for operation has an extensive pathological lesion in the stomach, often involving contiguous structures. Such patients present a technically difficult operative problem, and as a result must accept a relatively great operative risk, yet one must realize that operation is undertaken only when all else has failed. The future of the patient without operation is complete invalidism or early death.

In this series we had 6 deaths, or 17.1 per cent mortality. Three patients died of peritonitis. In one of these patients the condition demanded local anesthesia, and while attempting to put in a splanchnic block the ulcer became detached from the liver, leaving a base 2 by 1 inches, and the resultant opening in the stomach could not be controlled before peritoneal soiling occurred. This case is the one in which gastro enterostomy was carried out—obviously a resection would have been unwise. In the 2 other patients, edema was still present about the ulcer in the stomach wall. These cases provided the stimulus which has led us to treat all gastric ulcers primarily by Cleaver's method, even though we are reasonably certain that operation will ultimately be necessary. Such treatment results in the disappearance of the edema about

TABLE I—GASTRIC ULCER OPERATIONS
JULY 1, 1929, TO SEPTEMBER 1, 1937

	Cases
Total number of cases	35
Gastro-enterostomy	1
Resection	34
Pólya reconstruction	27
Schoemaker reconstruction	7
Hour glass deformity	8
Ulcer base undisturbed	13
Deaths	6
Pneumonia	2
Peritonitis	3
3 months after operation local abscess and duodenal fistula	1

the ulcer and thus has lessened local infection and the likelihood of peritonitis.

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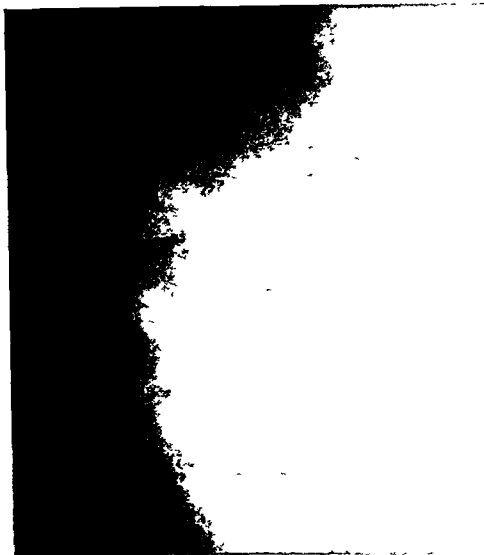


Fig 1. Case No 036036. Hepatic and common bile ducts outlined by barium during the course of a barium meal examination. The lesion was a posterior wall duodenal ulcer which had perforated into the common bile duct.

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The second group, comprising the younger



Fig. 2. Pointed incisura opposite small lesser curvature gastric ulcer



Fig. 3. Large ulcer on lesser curvature completely penetrating all coats; no incisura on greater curvature

individuals with a high free hydrochloric acid content in the stomach and no pyloric obstruction, presents the most difficult problem in the surgical treatment of duodenal ulcer. Before considering any operation on such a patient we must be convinced that all non operative therapy has been exhausted. We must be on guard lest lack of self discipline and failure of the patient to follow the outlined regimen be the cause of the persistence of the symptoms. No operative procedure can obviate the necessity for self discipline on the part of the patients. Any patient belonging to this group who has not acquired sufficient self discipline

to give up tobacco and alcohol and follow a strict dietetic regimen, should not be accepted for operation.

Having decided that an operation on a patient in this second group is necessary, we must determine whether the technical procedure will be of the indirect or the direct type. The indirect type is exemplified by gastroenterostomy, gastroduodenostomy, the Judd or Finney pyloroplasty, the Devine exclusion operation, with or without Bancroft's modification of removing the pyloric mucous membrane. Our experience with gastroenterostomy since the first of July, 1929, is shown in Table II.

Three deaths occurred and all were due to a non functioning stoma. We believe this to be the result of edema about the suture line as has been demonstrated by Lewis in our department. Such patients would now be saved by an indwelling duodenal tube accompanied by suction drainage. The follow-

TABLE II—GASTRO ENTEROSTOMY FOR DUODENAL ULCER

	N	mb
Total cases	89	
Deaths (3.3%)	3	
Anastomotic ulcers	11	
Proved by operation	7	
Clinical and radiological diagnosis	4	

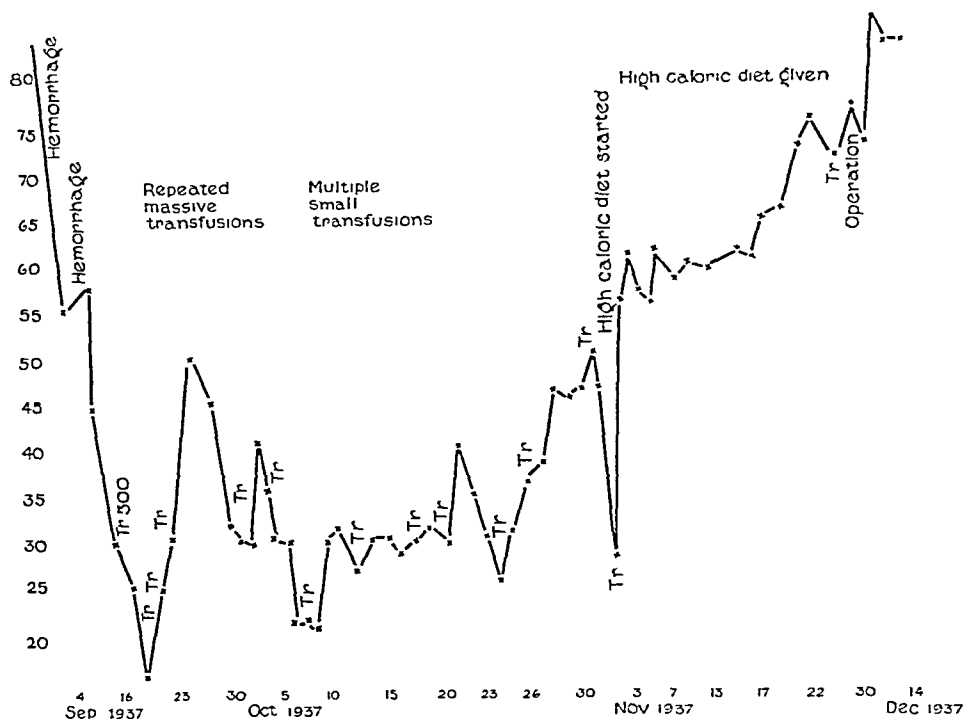


Fig 4. Graph showing the value of feeding patients who have suffered a violent hemorrhage, a diet with a high caloric value, rich in animal protein. Patient was admitted September 4, 1937, following severe hemorrhage. Between this date and November 2, had 18 transfusions of varied volume and interval. On latter date, a high caloric diet, rich in animal protein, was given, followed by a spectacular rise in hemoglobin permitting radical gastrectomy December 6.

up of this series revealed 11 jejunal ulcers. Seven were proved by reoperation. In 4, the diagnosis is based on x-ray and clinical evidence. Such a high percentage of jejunal ulceration is not a condemnation of gastro-enterostomy; it is a condemnation of our judgment in selecting cases suitable for gastro-enterostomy. In the 11 cases in which a stomal ulcer had developed there was no pyloric obstruction, and a high free hydrochloric acid content was present on gastric analysis. We now believe that a gastro-enterostomy is unsuitable for such cases. We have carried out the Devine operation on 4 patients, and 3 jejunal ulcers developed and the fourth patient died from perforation of the pyloric stump 3 weeks after operation. Several of our colleagues have had happy results with Bancroft's modification of Devine's operation. We have had no personal experience with this procedure. We would not do any type of py-

loroplasty for a patient in this second group. Our experience with gastroduodenostomy is confined to 9 cases, and was most unhappy. One died from obstruction at the stoma, due to axial rotation of the duodenum, the result of a technical error. One patient has been reoperated upon for an anastomotic ulcer. Sir David Wilkie, who has carried out this operation on 180 patients, stated in a recent conversation that the incidence of late postoperative sequelæ had led him to question the value of this operation. Such experience has led us to consider for this difficult group of patients the more radical procedure of a gastric resection, with or without the removal of the pyloric antrum.

The opponents of any type of gastric resection for duodenal ulcer base their opposition upon the following opinions: (1) it is an unnecessarily mutilating operation; (2) it is accompanied by a high operative mortality;

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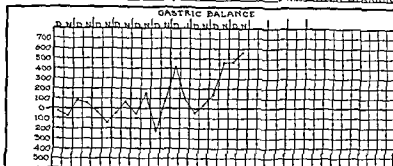


Fig 5 This graph records in 12 hour periods the relationship between gastric fluid intake and output. If output exceeds intake it is recorded below the zero line and if the intake exceeds the output it is placed above the zero line. This graphically shows when gastric emptying has been restored.

(3) it is followed by anemia and decreased economic efficiency, (4) it does not wholly protect the patient from the possibility of subsequent jejunal ulceration.

Our experience with gastric resection for duodenal ulcer extends over 11 years. We were in the beginning very loath to carry out a radical subtotal gastrectomy as originally advocated and practiced by Finsterer yet in all the patients upon whom we have operated, with the exception of the 4 in whom a Devine transection operation was done, section was made at the gastroduodenal junction and the whole or part of the pyloric antrum was removed. We have never practiced the operation advocated by Ogilvie of carrying out a radical gastrectomy but leaving the pyloric antrum intact. He based this procedure on the assumption that the anti-anemic factor originates in this area of the stomach. We removed the pylorus because we believed that it was the source of a hormone which stimulated acid gastric secretion. One advantage of

leaving the pylorus intact is the ease with which the closure may be accomplished and duodenal fistulas obviated. In this group of resections we have had one duodenal fistula and this was efficiently dealt with by means of Potter's technique.

Gradually, over a period of 8 years our operation of gastric resection became more radical. This attitude was determined by the results seen in the follow up clinic. For 3 years we have done a radical subtotal gastrectomy, removing the pylorus and most of the lesser curvature of the stomach. We have reached this decision for the following reasons: recurring ulceration occurred in some cases with small gastric resections. The free hydrochloric acid in the stomach is not decreased as certainly by a small as by a large gastric resection. We have not encountered a single case of anemia which was not due to insufficient food or a badly balanced diet, the latter explained in many instances by economic stress. Such patients readily responded to a proper diet with iron therapy.

We have come to believe that there is no very great handicap arising from the small stomach. Such is compatible with comfort and efficiency despite the diet, work, and environment of a laborer. The primary mortality in our series is not forbidding. This operation is followed by the lowest incidence of jejunal ulceration which we have experienced after any operative procedure. Table III shows the relative incidence of the various

TABLE III—TYPE OF OPERATION AND MORTALITY

	C. e.	12th	Per Cent
Total operations duodenal ulcer	46	6	13.0
Partial gastrectomy	31	3	9.7
Deaths dead due to radical operation for supposed cancer	139	1	7.2
Gastro-arteriotomy	80	3	3.7
Finsterer operation	15	0	0
Other operations	14	0	0

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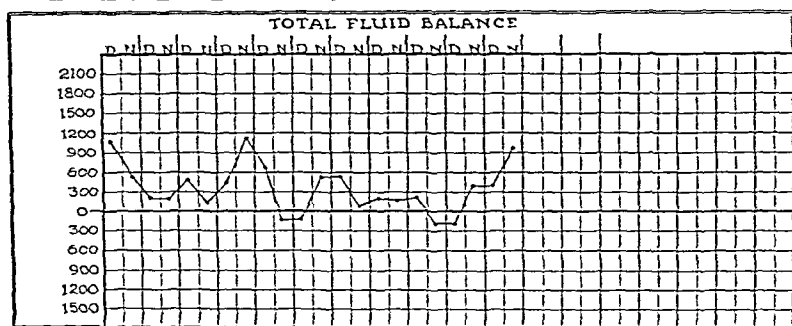


Fig 6 A graphic record of the balance between fluid intake, which includes that taken by all routes, and fluid output, which includes urinary output and fluid withdrawn through a duodenal tube. If the total fluid loss is greater than the intake, the volume of loss is recorded below the zero line, and if the fluid intake exceeds the loss, such volume of gain is recorded above the zero line. By means of this record it is easy to determine whether our method of procedure is maintaining an adequate fluid balance.

ous operative procedures together with the mortality. The late results of gastric resections for duodenal ulcer are tabulated in Table IV.

An analysis of the results of gastric resection reveals a low mortality. There were 3 deaths. One was believed to be due to pulmonary embolus on the tenth day. This was a clinical diagnosis, as no autopsy was permitted. The 2 other deaths were the result of an error in interpreting the gross pathological lesion. Both were interpreted as being malignant, and a very radical operation was carried out.

In the first case a diagnosis of pyloric carcinoma was made. The patient was an elderly male, admitted with coma and tetany from vomiting. After adequate pre-operative preparation, a gastric resection was carried out. He died of pneumonia, and had the correct diagnosis of duodenal ulcer been made, only a gastro-enterostomy would have been done. In the second case an erroneous diagnosis of carcinoma of the bile papilla was made and Whipple's resection of duodenum and pancreas, with transplantation of the common bile duct, was carried out. The patient died of peritonitis.

The mortality from a gastric resection for a recognized duodenal ulcer is very low. If we could exclude the 2 cases erroneously diag-

nosed in the gross as carcinoma from our series of 131 cases, we could present statistics of 129 resections for duodenal ulcer with 1 death from a pulmonary embolus, an accident which is apt to occur even with much more minor procedures. This would give an operative mortality of 0.77 per cent. When it is recalled that our operative procedure is carried out only on patients who are suffering from a serious lesion, which, having resisted all non-operative therapy, leaves the patient seriously disabled, then some risk is justifiable. That such a low operative mortality can be indefinitely maintained is too much to hope. That

TABLE IV.—LATE RESULTS OF GASTRIC RESECTION

	Cases
Total resections for duodenal ulcer.	131
Deaths (2.25%)	3*
Limited pylorectomy with Billroth I reconstruction	2
Recurrence and both subsequently died of hemorrhage	1
Limited pylorectomy and posterior Pólya	1
Recurrence re-operation, then further recurrence	1
Limited resection and gastroduodenostomy	1
Recurrence re-operation, and recurrence	1
Primary radical resection	1
A jejunal ulcer was suspected clinically and radiographically in January, 1937, but re-examination in September, 1937, showed no radiographic evidence of the presence of ulcer, and the patient was suffering no digestive disturbance	

*Two deaths were the result of too radical operation, as lesion was erroneously diagnosed as cancer.

†These 2 cases at present comfortable on medical regimen.



Fig 7 X-ray study of a short loop posterior gastroenterostomy taken in the erect position showing the stomach held up on the shelf of the gastrocolic omentum. Subsequent studies show the stoma to lie higher than the pyloric antrum with resulting imperfect drainage of the stomach and ultimate development of a jejunal ulcer.

it has been maintained over the period from the 1st of July, 1929, to date is due to a very careful selection of patients for operation, careful and adequate preparation, and perfect co-operation between the medical, surgical, and operating room staffs, combined with a careful and prolonged postoperative supervision of diet and work. The recurrences following the Schoemaker or Billroth I type of operation have evolved for us a definite principle. In one case the ulcer base in the pancreas was not removed, and in the second case a limited resection was done. We now believe that no type of resection accompanied by a gastroduodenal anastomosis should be carried out for a duodenal ulcer unless all the local pathological tissue, including the base of the ulcer, be excised. It thus becomes obvious that there will be practically no cases of duodenal ulcer which require operative therapy

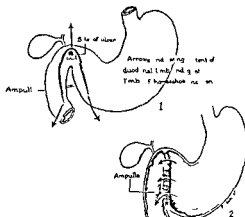


Fig 8 Details of Finney pyloroplasty in which the stoma is large and extends below the entrance of the common bile duct.

in which this procedure is applicable. In one instance with excision of a jejunal ulcer following a gastroenterostomy, the stump of stomach following a limited resection was anastomosed to the side of the descending duodenum. An anastomotic ulcer occurred in 6 weeks, and a massive hemorrhage occurred in 8 weeks after operation. Re-operation confirmed the clinical diagnosis of anastomotic ulcer. We have not used this type of reconstruction since.

When a radical subtotal gastrectomy with removal of the pyloric antrum and most of the lesser curvature was the primary operative procedure, we have to date only one case with possible stomal ulcer. This diagnosis is based only on clinical and x-ray studies made in January, 1937. The patient is comfortable on diet, and was carrying on his responsibilities as a captain in charge of a large lake freighter, until lightning pains in his legs enforced a rest. A repetition of his gastric and x-ray studies in September, 1937, showed no evidence of any organic lesion in his gastrointestinal tract. Has his tabetic state any association with the possible stomal ulcer?

In view of the foregoing data, when a patient's disability warrants a gastric resection we have abandoned all procedures except a radical subtotal gastrectomy, with removal of most of the lesser curvature and the pyloric antrum. Thus we believe to be the correct surgical procedure for the young individual with a high free hydrochloric acid content in

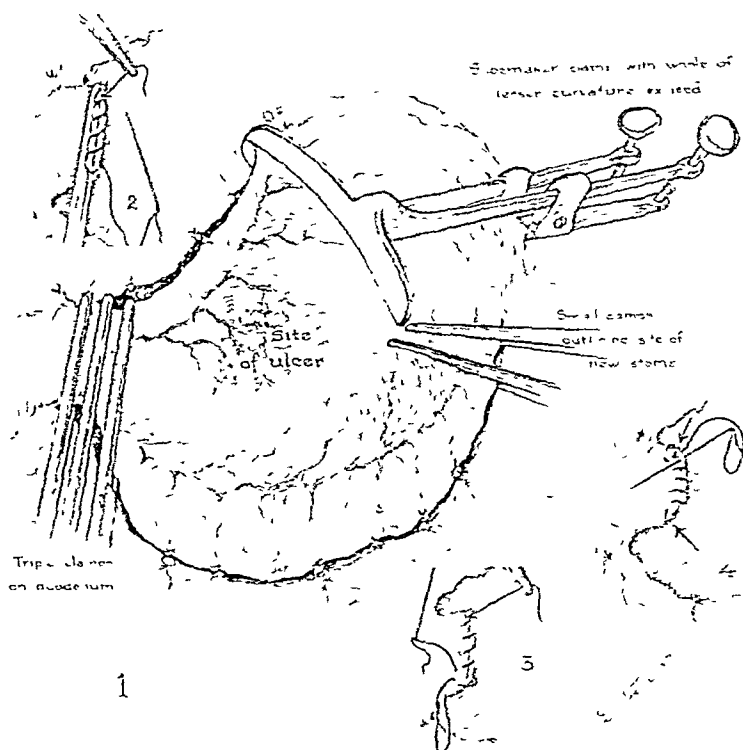


Fig 9 The application of the three forceps before the division of the duodenum, and the method of closing the duodenum. The application of the Schoemaker clamp is also shown and the method of outlining the stoma near the greater curvature.

the stomach, no pyloric obstruction, no history of massive hemorrhage, and a penetrating duodenal ulcer unrelieved by a non-operative regimen. Ogilvie, in a recent conversation, stated that he has had a disturbing incidence of jejunal ulceration following his cases of gastric resection in which the pylorus was left *in situ*. He is at the moment modifying his operative procedure.

In short, for all gastric ulcers in which operation is indicated, a subtotal gastrectomy with excision of the ulcer, is carried out. If the ulcer has invaded the pancreas or liver, the ulcer base is left undisturbed. We use a posterior gastro-enterostomy or a Finney pyloroplasty for a scar stenosis at the pylorus—a Finney pyloroplasty in the middle aged or elderly patient with a penetrating ulcer who has never had a massive hemorrhage and who has a low free hydrochloric acid content in the

stomach. Where massive hemorrhage has occurred from a duodenal ulcer, a subtotal gastrectomy is carried out, with ligation of the blood supply to the duodenum. In the young individual with a duodenal ulcer and obstruction, no massive hematemesis, and high free hydrochloric acid in the gastric contents, if operation be indicated, then a radical subtotal gastrectomy is advised. In duodenal ulcer occulta, a radical subtotal gastrectomy is carried out, the ulcer being left *in situ*, as any attempt at removal would be futile and disastrous.

Where acute perforation of a duodenal ulcer has occurred, we believe that the surgeon's sole responsibility is to save life. We have previously shown that the simple procedure of tying a free or pedunculated fat graft over the perforation is sufficient to accomplish this. The results obtained are shown in Table V.

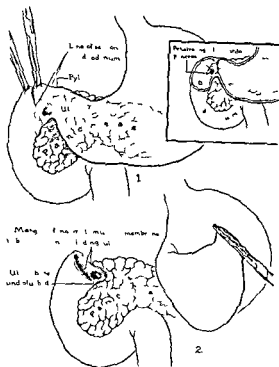


Fig 10 Scheme of dividing duodenum and separating the pyloric end of the stomach in the presence of a penetrating posterior duodenal ulcer preparatory to exteriorizing the ulcer

TABLE 1—ACUTE PERFORATED DUODENAL ULCERS

Total number of cases	60
Deaths (3.3%)	2
Dead pulmonary embolus on the tenth day	1
Dead cardiovascular accident on operating table	1

In a total of 60 consecutive cases operation has been done with 2 deaths. One death occurred on the tenth day from pulmonary embolus, and autopsy revealed healing at the site of perforation, and no peritonitis. The second death occurred in an elderly male while on the operating table before the ulcer was closed. He was the victim of serious cardiovascular disease, and we believe some cardiovascular accident occurred which was the cause of death. No autopsy was permitted. These results have settled for us beyond all argument the proper technical procedure to carry out for an acute perforation of a duodenal ulcer.

The immediate pre operative management

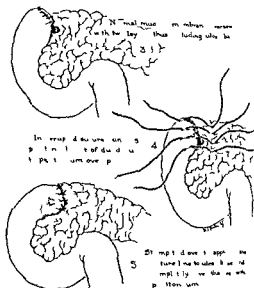


Fig 11 Method of closing duodenal stump and exteriorizing the base of penetrating posterior wall duodenal ulcer which has been left *in situ* and undisturbed

and preparation we believe to be of the utmost importance in safeguarding the patient during and immediately following the operation. We are firmly convinced no patient should be submitted to a major operation immediately following a prolonged bed rest and dietetic therapy. Such patients should be discharged from hospital, and be up and out of bed for at least 3 weeks before returning for operation. Such a management has definitely decreased the mortality and complications of our operations.

When pyloric obstruction from a duodenal ulcer is present, suction drainage of the stomach through an indwelling duodenal tube prolonged over 10 to 14 days, accomplishes a twofold purpose: first it permits restoration of tone in the overdistended stomach, second it is accompanied by the disappearance of the edema in the gastric wall. If operation be undertaken when the gastric wall is edematous, infection is more prone to occur along the suture line. We believe the infection in the edema about a gastric ulcer to be much more serious than such accompanying a duodenal ulcer. To free the gastric wall from edema is therefore most important in the prep-

TABLE VI.—DUODENAL FEEDING

	Grams
Cream 32%	580
Vitavose (Squibb's)	50
Whole milk	1180
Orange juice (6 oranges)	200
Liver extract.	200
Brewers' yeast	30
The whites of 6 eggs	
Soak vitavose in orange juice	Cut egg whites into milk
and cream	Mix with Dover egg beater
extract very carefully and slowly, or it curdles	Add the liver
The brewers' yeast is added just before using	
This amount provides sufficient volume for 48 hours' feeding. Contains —	

	Grams
Protein	80
Fat.	200
Carbohydrate	130

with a total caloric value of 2,640

This should be kept in a refrigerator until used

aration of the patient suffering a gastric ulcer. To accomplish this, x-ray examination should confirm the fact that the indwelling duodenal tube has entered the duodenum, in order that the stomach may be kept at rest. Feeding is carried out through the tube. Many mixtures may be used, but that shown in Table VI has proved efficient in our experience.

This mixture is given in doses of 1 to 3-ounce volume throughout the 24 hours, and in addition 3,000 cubic centimeters of 10 per cent commercial glucose in saline is allowed to drip into the stomach by means of an intravenous apparatus during the same period. This does not necessitate the patient being confined to bed, as the tube may be readily disconnected in order that the patient may take short walks about the hospital, and thus maintain general muscle tone. This regimen supplies 2,520 calories per 24 hours.

After 3 weeks the edema in the stomach wall about the ulcer is definitely lessened. This can be confirmed by x-ray studies showing increased motility of the gastric wall about the ulcer. The safety of the operation is therefore much greater. During this period of preparation it is necessary, in the patient suffering from pyloric obstruction from a duodenal ulcer, to supply fluid and nourishment by the intravenous administration of saline, glucose, and blood. Sufficient fluid must be administered to maintain a urinary output of 30 ounces or more in 24 hours. When the anemia is severe, and not responding to iron and die-

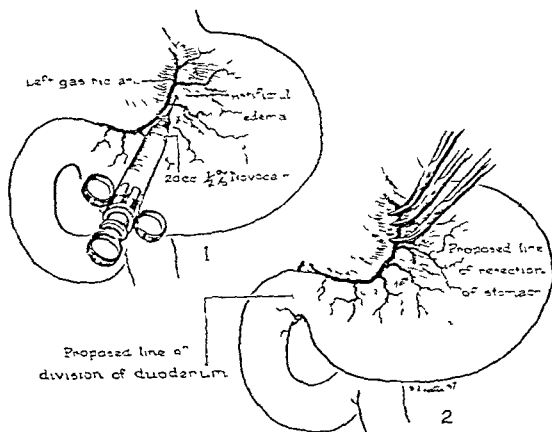


Fig 12. Production of artificial edema in gastrohepatic omentum high on the lesser curvature, with the method of isolating and triple clamping the left gastric artery.

tetic therapy, blood transfusion may be carried out. If the urgency for operation be great because of persistence of bleeding, the continuous drip transfusion advised by Marriott is admirable.

Mr. Gordon-Taylor (9) has stressed, however, that if massive drip transfusion be used as a pre-operative procedure on patients suffering from a severe hematemesis, it must be used immediately following the hemorrhage and operation undertaken as soon as a satisfactory hemoglobin level has been reached. We aim to raise the hemoglobin to 80 per cent before operation, and the transfusion is continued during and after the operation. His experience with this method of dealing with a severe hemorrhage accompanying a gastric or duodenal ulcer has been most happy. However, in instances in which he has deferred the drip transfusion until many days following the hemorrhage, when secondary anemia, with its associated disturbances, has become well established, the results have been disastrous, even though a high level of hemoglobin had been attained before operation. We have, however, on many occasions carried out extensive gastric operations on patients with a low hemoglobin. This is possible if a severe degree of anemia has persisted for some weeks, in order that the patient's metabolic processes may adjust themselves to a low level of hemoglobin. It then becomes possible to do exten-

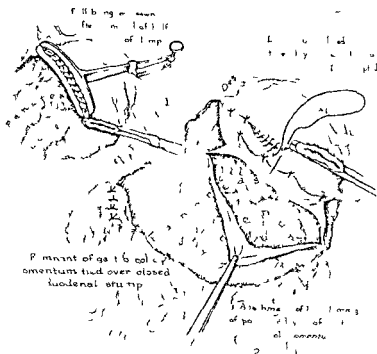


Fig 13 Method of closing the newly formed lesser curvature. The frill remaining after removal of half the clamp is oversewn and buried with a second layer of continuous catgut and reinforced with interrupted silk. Preparation for a posterior Polya reconstruction by uniting the lateral cut margin of the posterior layer of the lesser sac by interrupted sutures to the posterior wall of the gastric remnant. The method of suturing the remnant of the gastrocolic omentum over the duodenal stump to make a more secure closure is also shown.

sive operations in the presence of an established and severe anemia which would be disastrous if undertaken soon after the development of even less severe anemia.

After a massive hematemesis when the actual gross bleeding has ceased we give food by mouth. The volume and caloric value of the food is rapidly increased until within 4 or 5 days the patient is taking the full ward diet containing an abundance of animal protein, the only refinement being that the vegetables are puréed and the meat and fowl put through a mincer. We have no instance in which we considered this procedure to initiate further hemorrhage. The value of this type of high caloric diet containing an abundance of animal protein, in the therapy of patients who have suffered a massive hemorrhage, we believe is beyond question. It increases the hemoglobin

in a manner which in our experience, was impossible with previous ulcer diets (Fig 4).

A further pre operative preparation which we believe to be of value is to accustom the patient to the presence of an indwelling duodenal tube. All patients who are being operated upon for gastric or duodenal ulcer are sent to the operating room with a duodenal tube in the stomach.

Because following partial gastrectomy, peristaltic contraction is abolished in the resected stomach, and because edema is present in a varying degree about the suture line there is in some instances a temporary delay in gastric emptying. A gross postoperative gastric retention may be present in the absence of vomiting. In order that there should not be an undue amount of gastric retention a careful chart is made of the fluid intake and

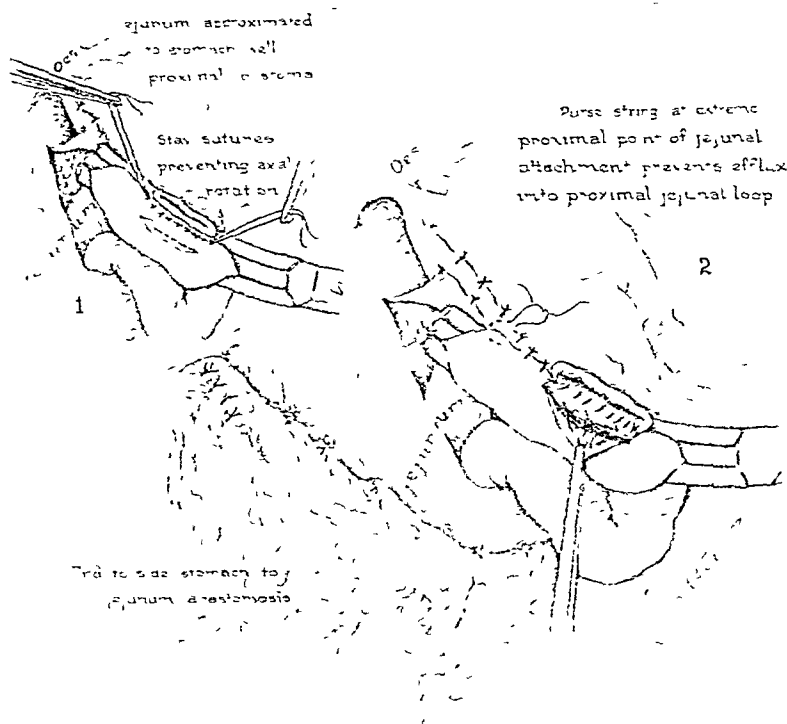


Fig 14 The use of the two stay sutures to prevent axial rotation of jejunum, also the insertion of pursestring sutures to hitch proximal jejunum well up on the lesser curvature, thus preventing gastric contents from emptying into proximal jejunal loop. Clamps are shown at the anastomosis for clarity, but we prefer to dispense with clamps, as they are too traumatic.

output in the stomach. Suction through the tube empties the stomach at frequent intervals. This prevents any undue strain on the suture line from overdistention of the resected stomach. Further, it prevents an increase of the edema in the stomach wall which is always associated with gastric retention. The fluid intake and output from the stomach is recorded on a graphic chart (Fig 5). The total fluid balance is also recorded and expressed graphically on a chart (Fig 6). This total fluid balance is determined by estimating the intake as the total fluids administered by mouth, rectum, interstitially, or intravenously. The fluid output is estimated as the fluid which has been withdrawn from the stomach in addition to the urinary output. This obviously neglects fluid loss by respiration and perspiration, but if sufficient fluid is administered to ensure a urinary output of

30 ounces or more in 24 hours, the patient is definitely protected against dehydration. If normal emptying of the stomach be unduly delayed over 5 or 6 days, we believe that edema about the suture line is an important contributing cause. Following the suggestion of Ravdin, we give such patients a transfusion of 500 cubic centimeters of citrated blood, for the sake of the serum protein which they receive. This procedure has, on occasions, given most spectacular results, even though with the methods available we had not been able to demonstrate a low serum protein.

The anesthesia we believe to be important. If the patient be elderly, or very markedly undernourished, a preliminary sedative of morphia and hyocine followed by an abdominal wall block with one-half per cent novocain, accompanied by splanchnic anesthesia after the method of Braun, is the procedure of

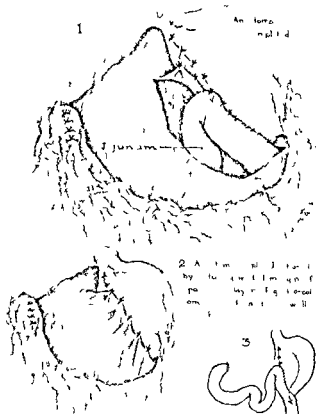


Fig 15 The completion of the retrocolic anastomosis the medial layer of gastroduodenal omentum being sutured to the anterior wall of the stomach. The duodenal stump is covered with fat and the diagram (inset 3) shows the proximal jejunal loop well sutured on the newly formed lesser curvature showing how the discharge of gastric contents must go into the distal jejunal loop.

choice. In the more robust individual, we represent the minority who favor spinal anesthesia. We use nupercaine. Our experience with this type of anesthesia, administered and supervised by an expert anesthetist has been most happy. The meticulous dissection and freedom from operative trauma possible with this procedure is of great advantage to primary healing, with a minimum of tissue reaction and wound pain.

We have for many years made a practice of giving a citrate blood transfusion of 500 cubic centimeters volume during the operation whenever a gastric resection has been performed. This has not been associated with any regrets. The satisfactory convalescence which our patients experience we believe to be due in part at least to this procedure.

While chest complications follow all types

of anesthesia, we believe that the absence of constricting abdominal dressings and the elimination of heavy retention sutures in the abdominal wall enabling the patient to breathe freely and with less pain is of real value. Expert nursing, which includes rolling the patient from side to side every 2 hours and stimulating overbreathing by having the patient frequently inhale carbon dioxide for the first 48 hours following operation, will decrease greatly the incidence and seriousness of the postoperative chest complications. A serious pneumonia is now an infrequent postoperative complication.

A detailed account of all the technical procedures is quite superfluous. There are, however, a few procedures which we have found of value in gastric operations. In the performance of a posterior gastro enterostomy, we are

impressed with the value of a long proximal jejunal loop. If a short or no-loop type of operation be done, particularly in a long-waisted, viscerotopic individual, the stoma in the erect posture is held up to a higher level than the greater curvature of the stomach. This results in an imperfect emptying of the pyloric antrum, and can readily be demonstrated by x-ray studies (Fig. 7). The important technical procedure in a satisfactory Finney pyloroplasty is a thorough mobilization of the descending duodenum. By incising the peritoneum lateral and parallel to the long axis of the second portion of the duodenum, this may be readily accomplished without trauma or blood loss. The stoma should be ample, and should reach a level distal to the entrance to the common bile duct or the ampulla of Vater (Fig. 8). Observance of these 2 points is essential to achieve the results of which this operation is capable. Since we have come to appreciate these details, and have learned how to mobilize the duodenum easily and safely, we are increasing the application of this operation.

In a subtotal gastrectomy, the lesser sac is opened below the greater curvature. This enables the identification and protection of the middle colic artery. As the division of the anterior layer of the lesser sac is carried toward the duodenum, the division by knife dissection of the reflection of the peritoneum onto the posterior wall of the pyloric antrum, together with the division of the peritoneum on the medial and lateral sides of the descending duodenum and duodenal cap, exposes adequately the duodenal blood supply and thoroughly mobilizes the first portion of the duodenum. This latter we believe is of the utmost importance in permitting an efficient closure of the duodenal stump and eliminating duodenal fistulas. The pyloric vessels and the duodenal branch of the pancreaticoduodenal artery are triple clamped and divided in such a manner as to leave two clamps on the stumps of the vessels. This permits of placing with ease and accuracy, on the proximal portion of the vessels, two ligatures, and does much to prevent accidental hemorrhage.

Shenstone's method of closing the duodenum is accomplished simply, by virtue of

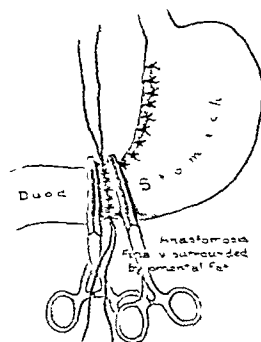


Fig. 16 Details of the end-to-end gastroduodenal anastomosis as originally suggested by Schoemaker.

the free mobilization (Fig. 9). Three Kocher hemostats are placed across the duodenum just distal to the pyloric sphincter. Division of the duodenum is made, leaving 2 forceps on the stump. One of these is removed, and the frill of crushed duodenum oversewn. The second clamp is then removed, and with the same suture a second row of sutures is inserted which effectively imbeds the first row. If the first suture of this second layer is placed parallel to the long axis of the duodenum and then continued as an over and over stitch, it invaginates the corner very well, and the opposite corner is closed by ending the over and over stitch as a purse string. A third row of interrupted sutures of fine silk tied over the fatty remnant of the gastrocolic omentum completes a very satisfactory closure.

Occasionally a posterior wall duodenal ulcer is large and penetrating into the pancreas. Under such circumstances the duodenum is opened laterally just distal to the pyloric sphincter, and the stomach and duodenal cap trimmed away, thus leaving the ulcer base undisturbed (Figs. 10 & 11). The mucous membrane of the duodenum is closed by an over and over suture, and thus exteriorizes the ulcer base. A second layer of over and over serous to serous suture reinforces the closure.

With interrupted silk sutures approximating the peritoneum over the pancreas and the peritoneum of the lateral wall of the duodenum, the closed stump is forced into the ulcer base, and the whole area is thus reperitonealized. This not only assures ade-

quate closure of the duodenal stump, but also protects the general peritoneal cavity should any pancreatic secretion leak from the ulcer base, as such would readily find its way into the lumen of the duodenum. When the duodenum is adequately closed, the pyloric end of the stomach which had previously been wrapped in gauze and tied with hernia tape, is carried to the left. Sharp knife dissection and division of the peritoneal reflection of the lesser sac onto the fundus of the stomach will free the stomach to a remarkable degree. Injection of the gastrohepatic omentum above the lesser curvature just distal to the esophagus with 20 cubic centimeters of $\frac{1}{2}$ per cent novocain accomplishes two purposes (Fig. 12)—first, the straining and vomiting which occasionally accompany the necessary traction of the lesser curvature at this stage of the operation are eliminated. Second, the artificial edema produced permits the easy and bloodless isolation of the left gastric artery from the lesser curvature of the stomach. This artery is triple clamped and doubly ligated in a manner similar to that used in controlling the duodenal blood supply. The application of a Schoemaker clamp enables a safe and radical excision of the lesser curvature, the size of the gastric stoma at the greater curvature being determined by the application of crushing forceps with blades 2 inches long (Fig. 9).

The closure of the lesser curvature is accomplished by oversewing the frill remaining after removal of the outer half of the Schoemaker clamp and burying this line of suture by a second over and over continuous catgut suture. A third layer of interrupted fine silk sutures completes the closure of the newly formed lesser curvature (Fig. 13). The restoration of continuity of the gastro intestinal tract may be accomplished either by an anterior or a posterior Polya. If the former is employed, an enterocenterostomy should not be carried out. It is unnecessary and nullifies whatever virtue there may be in the intimate contact of the biliary, duodenal and pancreatic secretion with the gastric contents.

Axial rotation of the jejunum in gastro jejunal anastomoses is responsible for many of the mal functioning stomas. We have been amazed how easily and unwittingly such ro-

tation is accomplished, even when one is on guard against such an eventuality. We have found that an interrupted stitch placed between the stomach and jejunum at either end of the proposed stoma, and held so as to produce tension along the proposed suture line during the completion of the anastomosis will prevent such a technical error (Fig. 14). One or two pursestring sutures holding the proximal limb of the jejunum over the distal inch of the newly constructed lesser curvature accomplish 2 purposes: first, they secure against leakage at the angle formed between the reconstructed lesser curvature and the jejunum. Second, they prevent the stomach from discharging its contents into the proximal jejunal loop (Fig. 15). If the resection be carried out for a gastric instead of a duodenal ulcer, we choose, when conditions permit a restoration of gastro intestinal continuity by the Schoemaker technique. Instead of closing the duodenum, a single non crushing clamp controls the duodenal stump until the operation has proceeded to the completion of the closure of the new lesser curvature. Then an end to end anastomosis is carried out between the stoma at the greater curvature of the stomach and the duodenum (Fig. 16). The line of anastomosis is then encircled by the remnant of the fat containing gastrohepatic omentum.

This insures a safe and satisfactory union. A meticulous and accurate closure of the abdominal wall with the elimination of heavy retention sutures in the skin completes the operation. The dressing is simply a strip of gauze held over the wound with mastisol. This eliminates all constricting abdominal binders.

Water by mouth is allowed frequently, as soon as the patient is returned to bed not more than an ounce being given at one time. Other food is withheld until gastric emptying has been satisfactorily established. In 8 to 10 days after this period the diet has been increased until it becomes a non residue diet containing adequate animal protein, the vegetables being puréed and the meats put through a mincer. Careful supervision of the convalescence and the observance of a sound medical regimen for 6 months after operation are

essential Tobacco should be permanently dispensed with

SUMMARY AND CONCLUSIONS

1 In duodenal ulcer, surgical therapy becomes necessary only if the complications of perforation, penetration, stenosis, or recurrent hemorrhage are present.

2 Operation for benign gastric ulcer will rarely be necessary if Cleaver's method of medical regimen is instituted

3 Operation must secure relief of symptoms, restored efficiency, and the greatest possible security against recurrence of ulceration

4 A consideration of the site of the ulcer and the character of the gross pathological lesion, together with the accompanying biochemical and physiological disturbances, is essential in determining the optimum operative procedure for the individual patient

5. An operation must decrease the free hydrochloric acid content of the stomach, relieve gastric and duodenal spasm, establish efficient gastric emptying, include the excision of all gastric ulcers, and ligature of the blood supply of the duodenum in the cases in which a duodenal ulcer is accompanied by massive hemorrhage

6 The optimum operation for any patient is based upon the following data: the age of the patient; the results of fractional gastric analysis, the presence or absence of pyloric stenosis, if stenosis be present whether due to scar or edema, the site of the ulcer; and the degree of self-discipline which the patient has achieved

7 In a patient suffering a duodenal ulcer

with scar stenosis, we advise a posterior gastro-enterostomy or a Finney pyloroplasty. If there is no pyloric stenosis, in an elderly patient with a low free hydrochloric acid and no massive hematemesis, we do a Finney pyloroplasty. In all other indications for operation for duodenal ulcer we do a radical subtotal gastrectomy, with removal of the pyloric antrum.

8. A subtotal gastrectomy with excision of the ulcer is the procedure of choice when operation is required for a gastric ulcer.

9 In an acute perforation of a duodenal or gastric ulcer, simple closure as outlined is all that is necessary to save the patient's life.

10 Pre-operative and postoperative safeguards are enumerated.

11. Important technical details of the various operative procedures are outlined

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LESIONS OF THE INTERVERTEBRAL DISC AND LIGAMENTA FLAVA

Clinical and Anatomical Studies

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OVER a period of years much speculation has centered about the mechanism responsible for low back pain in that group of patients in whom a diagnosis has been made of disorders of the sacro iliac joint, the lumbosacral region, or both. Moreover, most of these patients have shown no x ray evidence of abnormality, and such cases have been fruitful sources of debate and argument as to the underlying cause of the disability. As might be expected when no well defined pathological changes are recognizable, the treatment has not been satisfactory. At various times attention has been directed primarily to the removal of focal infections and again to the correction of what were considered to be skeletal or postural strains with various functional disturbances.

While such symptoms may be produced by a variety of causes attention to two structures concerned in the production of these symptoms—the intervertebral discs and the ligamentum flavum—will demonstrate the source of a considerable number of them. Either an injury to the intervertebral discs or a thickening of the ligamentum flavum, or both, may be responsible. Displacements of portions of the intervertebral discs, particularly the central portion which herniates backward into the spinal canal, and injury to the ligamentum flavum with subsequent thickening and fibrosis, can be demonstrated pathologically.

The patients in whom these changes have been found are not ordinarily those with mild or transient pain. We have in fact, seen a number selected from many others because of the intractable character of their pain which had resisted varied forms of treatment. Most

of our patients were referred by orthopedic surgeons after prolonged efforts had been made to give relief. Strapping, postural exercises, massage and baking, plaster casts and jackets, traction, fasciotomy (Ober), and even lumbosacral and sacro iliac fusions had been tried. These are mentioned to indicate that the patients in the group which we are discussing have had severe and really intractable pain. It is our experience that when such a group of selected patients is studied, the incidence of displacement of a portion of an intervertebral disc or enlargement of the ligamentum flavum, or both, will be found to be very high.

We have again reviewed and investigated anatomical factors bearing on these lesions and the mechanisms involved. From the literature and from recent detailed dissections by Drs. Verne Inman and John Saunders of the University of California staff, certain important relationships have evolved.

Owing to the great interest which has been displayed in recent years with regard to lesions affecting the intervertebral disc, it is hardly necessary to give here more than a very brief outline of the structure of this important organ, an outline necessary as a preliminary to a discussion of the ligamenta flava, intervertebral canal, spinal nerves and injuries related to them.

The space between each two vertebral bodies is occupied by the intervertebral fibrocartilaginous disc. The intervertebral discs vary in vertical thickness in different parts of the vertebral column. They are thinnest from the third to the seventh thoracic vertebra and thickest in the lumbar region. In both lumbar and cervical regions each disc is thicker anteriorly than posteriorly, in this wise assisting in the production of the anterior convexities which characterize the vertebral column.

From the Departments of Surgery and Anatomy, University of California Medical School.
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in these regions. In the thoracic region, the reverse occurs in correspondence with its anterior concavity. Apart from variation in detail, the anatomy of each intervertebral disc is essentially the same.

Each individual disc consists essentially of three parts. First, a circumferential portion formed for the most part of oblique and spirally arranged fibers passing from one vertebra to the other, but exhibiting regionally great variations, no doubt associated with variation in function. In section this portion is arranged in a series of concentric lamellæ and has received the name annulus lamellosus or fibrosus. The annulus is firmly attached into the substance of the adjacent bone by means of the so called fibers of Sharpey and may be regarded, for practical purposes, as equivalent to the capsule of the joint. It is supported anteriorly by the anterior longitudinal ligament and posteriorly by the posterior longitudinal ligament. The anterior longitudinal ligament is a wide, well defined structure exhibiting, characteristically, expansions at the level of the discs. On the other hand, the posterior longitudinal ligament is a poor, ill defined structure supporting the disc only in the middle line and often displaying deficiencies where it is related to the disc. It is important to note that posterolaterally on either side where the disc comes into relationship with the intervertebral foramen, it is unsupported by any extrinsic ligamentous structure. In these regions the disc frequently bulges backward to occupy a considerable portion of the lower half of this foramen.

Second, a soft, pulpy, elastic portion approximately occupying the center of the disc and constituting what is known as the nucleus pulposus. This pulpy center is of peculiar functional significance. It has arisen in part from the primitive axis about which the embryo has developed—the notochord. In the healthy disc it possesses a considerable inherent turgor and elasticity and because of these properties it serves to distribute pressure over the vertebral body. It can be most nearly described as an elastic ball-bearing, changing in shape and position under functional demands, and so distributing and absorbing the mechanical shocks to which the spine is con-

tinually subjected. In the lumbar region the nucleus pulposus is placed a little dorsal to the center of the disc, and in flexion it tends to move in a still more dorsal direction.

Third, the fibrocartilaginous disc is bounded above and below by cartilaginous plates which cover the bearing surfaces of the contiguous centers. These cartilage plates, though regarded by some as analogous to the articular cartilages of other bones, really constitute an integral part of the disc, bounding it above and below so that it possesses a drum-like form. This conception we owe to Schmorl.

We know of no adequate detailed anatomical description of the ligamenta flava. They consist predominantly of yellow elastic tissue and join adjacent laminae and articular processes. Whereas the ligamentum flavum is a continuous structure, it is convenient both for descriptive and clinical reasons to subdivide it into two portions. The medial half, the broader and thicker part of the ligament, is attached to the contiguous laminae and may with advantage be called the interlaminar portion. The thinner lateral half is less wide and tapers off as it extends laterally. It is attached predominantly to the articular processes and is related to the interarticular joint and capsule. This part will be referred to as the capsular portion. This division into interlaminar and capsular portions is suggested by some difference in direction of the fibers of the two parts. The fibers of the interlaminar part are vertical in position, whereas those of the capsular portion run obliquely downward and laterally (Fig. 2).

The interlaminar portion is attached inferiorly to the upper border of the lamina below. This attachment is indicated on the bony specimen by a well defined groove (Fig. 1, inset), the anterior margin of which variously exhibits sharp, thin plaques or spicules of bone which extend up into the anterior face of the corresponding ligament. These spicules are variable in size, number, and position and may perhaps be regarded as ossification in the ligamentum flavum, but we have noted that they are attached to the lamina and are more in the nature of an ossific extension from the bony attachment. Calcareous matter has been observed in the ligamentum flavum removed at

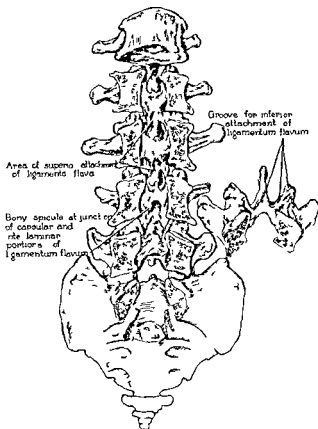


Fig. 1 Frontal view of the articulated lumbar spine. The vertebral bodies have been removed at their junction with the pedicles thus permitting examination of the dorsal wall of the bony vertebral canal.

operation, and, in our opinion this is in part nothing but ossific matter derived from these spicules which must necessarily be fractured from their attachments when the ligament is surgically removed.

Superiorly the interlaminar portion is attached to a well defined irregular and rough area, occupying the lower half of the lamina (Fig. 1). This area is separated from the smooth upper half of the lamina by a sharp ridge. The ridge characteristically exhibits a small bony spicule at the junction of the attachments of the interlaminar and capsular portions, but the bony plaques found below have not been observed at the upper attachment. Owing to this arrangement, the inferior half of each lamina is excluded anteriorly from

the neural canal and the upper smooth half of the lamina alone is directly related to the spinal dura. The medial end of the interlaminar portion blends with its fellow of the opposite side in the midline at the base of the spinous process. Laterally, each interlaminar portion is continuous with, and almost inseparable from the capsular moiety, except for the difference in direction of the fibers of the two parts. The interlaminar portion is for the most part a direct posterior relation of the spinal dura.

The capsular portion is attached below to a groove (Fig. 1) which extends along the periphery of the inferior articular process to a point a little beyond the intervertebral foramen. Above the ligament is attached to the

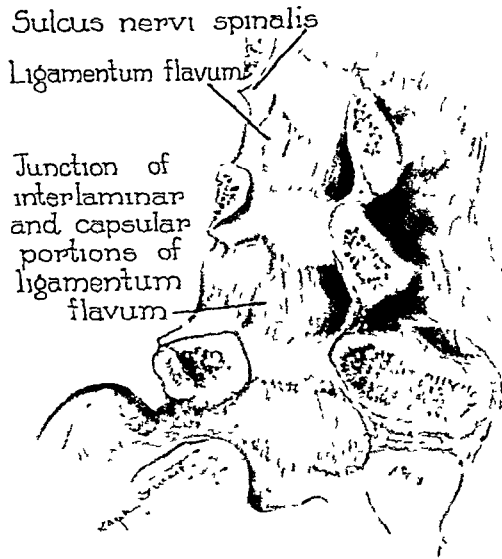


Fig 2 Dissection of the right posterolateral wall of the vertebral canal in the lumbar region. The attachments and extent of the ligamenta flava are clearly shown.

inferior border of the pedicle and lies just below the groove for the spinal nerve (Fig. 2) which is found on the inferior aspect of this structure. Laterally the ligament, considerably attenuated, blends with the capsule of the interarticular joint, some little distance lateral to the intervertebral foramen. This portion of the ligament excludes the joint from the neural canal and from the lower half of the intervertebral foramen.

The intervertebral foramina of the lumbar region are of special clinical significance and will receive major consideration here. The bony foramen or the foramen as visualized by x-rays, is approximately the shape of an inverted pear. This description scarcely holds for the fifth lumbar foramen which is more oblique and irregular, as is likewise, though to a lesser extent, the fourth. In x-ray examinations it is observed that the shape of the foramen changes with alteration in position, being larger and more elongate in flexion. Its upper boundary, formed by the pedicle and, more anteriorly, by the lower part of the vertebral body of the upper of the two contiguous vertebrae, is deeply notched (inferior vertebral notch). The spinal nerve, closely applied

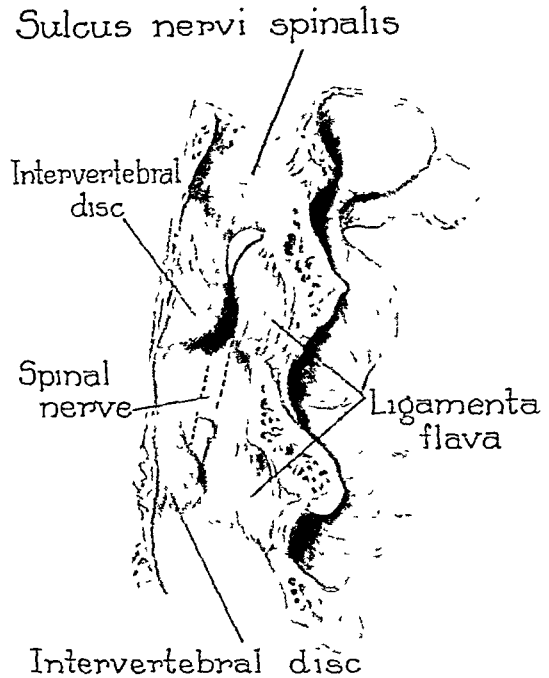


Fig 3 Dissection of the third and fourth lumbar intervertebral foramina, viewed from within the vertebral canal. The apposition of the intervertebral disc and ligamentum flavum obliterates the inferior half of the bony foramen. The spinal nerve leaves through the upper half of the bony foramen. Note the relationship of the outlined nerve to the sulcus between the ligamentum flavum and the disc at the foramen above that of its exit.

to the medial surface of the pedicle, grooves this structure, forming the sulcus nervus spinalis (Fig 2). This sulcus, in the case of the upper lumbar foramina, extends onto the inferior aspect of the pedicle at the apex of the inferior vertebral notch. At the fifth lumbar foramen and to a lesser extent at the fourth, the sulcus extends obliquely forward for some distance outside of the foramen, grooving the root of the pedicle, base of the transverse process, and adjacent body. In consequence, the fifth lumbar nerve, which has a very oblique anterior and downward inclination, is almost completely overhung by bone and lies close in to the lateral side of the body. It is important to recognize that the spinal nerves of the lumbar region occupy only the uppermost portions of their respective intervertebral foramina, closely applied to the

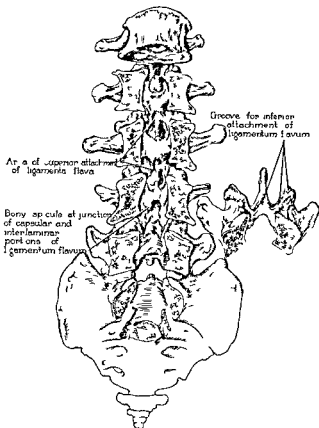


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usual, or be about to emerge from the sac, or may have just emerged, enclosed within its own sheath. It should be recognized that the nerve, no matter what relation it bears to the dural sac, is lying at this point in the sulcus between the intervertebral disc and the ligamentum flavum on the medial aspect of the lower half of the intervertebral foramen above that which gives it egress. Furthermore, the nerve is relatively fixed in this region because of its proximity to its point of emergence, although lying within the spinal dura. It has also been observed that the spinal theca in this region is normally slightly indented (Fig. 4) by the disc anteriorly and the ligament posteriorly with the nerve occupying the interval. These intimate relationships are of the greatest importance, for in this position the nerve is peculiarly vulnerable to encroachments by either the ligamentum flavum or the intervertebral disc, or both.

Protrusions from the posterolateral portion of the intervertebral disc may encroach upon the intervertebral foramen or protrude posteriorly and involve the nerve passing to the foramen below, in the latter case deforming the spinal theca at the level of the intervertebral disc above the foramen of the nerve involved.

We have had the unique opportunity of examining, postmortem, an instance of enlargement of the ligamentum flavum and observing its precise relationships. This example was found in the course of dissection on cadaver material and in consequence no history is available. The lesion occurred at the level of the lumbosacral junction on the left side. The ligamentum flavum was considerably enlarged, rough, irregular, and nodular. It protruded forward, impinging on the first sacral nerve. The nerve was found almost buried in the sulcus between the enlarged ligament and the corresponding disc.

The relative violent forces which act upon the spinal column are perhaps not sufficiently well appreciated. The column itself, freed of muscles, maintains a state of equilibrium to which it tends to return when a deforming force is applied. This equilibrium is established by two forces necessarily equal, but acting in opposite directions. One of these forces is

expansive and tends to separate the vertebral bodies. It depends upon the turgor of the intervertebral discs. This force has been experimentally ascertained in the cadaver, by Petter, to approximate 30 pounds in the individual discs of the lumbar region. The other force is tensile and resists separation of the vertebral bodies. It depends upon the various ligaments such as the annulus lamellous, the anterior and posterior longitudinal, the interspinous, the supraspinous, and intertransverse ligaments. The elastic nature of these forces permits of spinal movements. When these forces are liberated by separation of the neural arches from the bodies, the expansile force residing in the nucleus pulposus elongates the anterior part of the column while the tensile force of the various ligaments of the neural arches shortens the posterior portion. The change approximates 10 per cent of the total length of the column. These intrinsic forces, together with the primary and secondary curves, give to the column its extraordinary resiliency.

Under functional stress, the pressure exerted upon and distributed through the lumbar vertebræ and intervertebral discs must be enormous. They must, of course, carry the superincumbent body weight. Furthermore, in lifting a weight, the lumbar region carries the brunt of the pressure attendant upon use of the spinal column as a lever of the third class. We have estimated by analysis of the force vectors, resultant upon the lower lumbar discs in lifting a weight of 50 pounds, that this pressure amounts, under average conditions, to about 500 pounds. Under other conditions, there are fleeting periods during motion in which the pressure is considerably in excess of this rough estimate. In addition, when the spine is flexed, the nucleus pulposus in the lumbar region migrates dorsally, tension is thrown upon the posterior portion of the annulus and, if some rotation should accompany flexion, the annulus is further subject to torsional stresses. The magnitude of these forces, the dorsal migration of the nucleus, the stresses thrown upon the posterior part of the annulus, no doubt account for the greater frequency of dorsal herniations in the lower lumbar region. These are sufficient to account

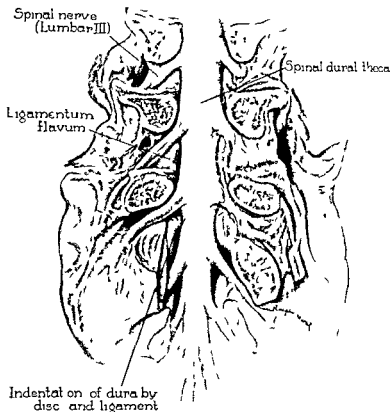


Fig 4 A dissection exposing the vertebral canal and its contents in the lumbosacral region by removal of the vertebral bodies. The lateral relations of the spinal theca and the course of the spinal nerves through the intervertebral foramina are shown

inferior aspect of the pedicle, and bear no direct relationship to the lower half of the foramen. The relationship of nerve to interarticular joint is very slight, occurring only at the most lateral part of the joint. At this point the nerve is no longer within the foramen proper, but at its wide and funnel like exit.

The lower half of the foramen is bounded below by the shallower superior vertebral notch on the upper aspect of the pedicle below. This portion of the foramen is narrow (Fig 3) and bounded anteriorly by the backward protrusion of the intervertebral disc and

posteriorly by the forward bulging of the ligamentum flavum, due to partial offsetting of the inferior articular process. With the soft tissues intact, this portion of the foramen is little more than a slit. In some instances these structures are in actual contact.

On the medial side of the lower half of the intervertebral foramen the apposition of the backward bulging intervertebral disc and the forward protrusion of the ligamentum flavum create a definite sulcus (Fig 3). This sulcus is related to the spinal nerve. Due to individual variations, the nerve may be lying at this point, within the dural sac, as is more

usual, or be about to emerge from the sac, or may have just emerged, enclosed within its own sheath. It should be recognized that the nerve, no matter what relation it bears to the dural sac, is lying at this point in the sulcus between the intervertebral disc and the ligamentum flavum on the medial aspect of the lower half of the intervertebral foramen above that which gives it egress. Furthermore, the nerve is relatively fixed in this region because of its proximity to its point of emergence, although lying within the spinal dura. It has also been observed that the spinal theca in this region is normally slightly indented (Fig. 4) by the disc anteriorly and the ligament posteriorly with the nerve occupying the interval. These intimate relationships are of the greatest importance, for in this position the nerve is peculiarly vulnerable to encroachments by either the ligamentum flavum or the intervertebral disc, or both.

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for herniation, in a normal disc, from a single trauma. In others, repeated trauma of the discs with attendant weakening of the annulus, or in those with such degenerate changes as we have often observed, these forces alone would serve as an adequate cause of herniation. It should be further noted that, in reaching forward to one side, the anatomical arrangement in the lumbar region is such as to limit that rotation which so freely occurs in the thoracic segments. This limitation forces lateral bending in the lumbar region, which puts the major stress on the posterolateral portion of the annulus and ligamentum flavum of the contralateral side. Such a mechanism would readily account for the unilaterality of lesions to one or both of these structures occurring in the neighborhood of the intervertebral foramen and involving, in the case of the ligamentum flavum, its capsular portion.

It is many years since Virchow demonstrated that, in flexion of the spine the lumbar region contributes very little to the movement except in that the curve is obliterated and the segment becomes straight. This limitation of movement is in contrast to that which occurs in extension. Phylogenetic history in the adoption of the orthograde position, evidences the enormous development of the sacrospinalis muscles necessary for the maintenance of the erect posture. These muscles have their *point d'appui* on the lower thoracic cage and thoracic spine. They play over, rather than on the lumbar segments. The lumbar spine may be regarded, in consequence, as a single lever. It is apparent that, should the lumbar spine develop an anterior concavity, the tendency would be for the sacrospinalis muscle to approach the axis of the lumbar spine. Such an approach would place the muscle in a position of mechanical disadvantage for protection of the spine, or for recovery from the hyperflexed position. The difficulty of lifting a heavy weight with the fully flexed spine is a familiar observation. Likewise when the spine is forced into hyperflexion its integrity is no longer fully guarded by the musculature and strain is thrown upon the dorsal ligaments and ligamentum flavum, notably the interlaminae portion. Such a mechanism sufficiently explains injuries to the ligamentum flavum. The

association of lateral bending with forward flexion in producing unilateral lesions has already been discussed.

It has been pointed out that structurally the ligamentum flavum consists predominantly of elastic tissue and is normally under tension. When torn or injured it fibers, retracts. Healing occurs by scar formation. That such scars should undergo hypertrophy is not surprising. Numerous examples of such hypertrophies can be observed in other situations. They characteristically occur in such regions where movement is unavoidable and free, such as on certain parts of the abdominal wall and in the neck. The persistent stimulation of healing wounds results in excess of fibrous connective tissue, and hypertrophy is greatest where movement is most. Gregg pointed out that such hypertrophied scars are not true keloids but a local response to stimulation and that they are merely hypertrophied cicatrices. Once injury and scar formation occur in the ligamentum flavum, there can be no question that the factor of movement is continually operative, resulting in hypertrophy of the cicatrix. These conclusions are confirmed by the appearances of every example of hypertrophy of the ligamentum. We have been able to examine histologically

Though displacements of cartilage and fibrocartilage from the intervertebral discs may occur at any level of the spine, the majority will be found in the low lumbar region, most often between the fourth and fifth lumbar vertebrae though sometimes between the fifth lumbar vertebra and the sacrum, or between the third and fourth lumbar vertebrae. The production of symptoms by enlargement of the ligamentum flavum has in our experience been limited to the same low lumbar region, for although these structures are present higher up they are much thinner and are not subject to the same gross alterations.

Over a period of years, cartilaginous masses have been removed from the spinal canal by various surgeons after a diagnosis of tumor of the spinal cord had been made. Less often, but in a considerable number of instances, alterations in the ligamenta flava have been found and have been noted in the literature. The nature of the cartilaginous masses and the

source have only recently been thoroughly understood. Frequently they have been considered to be new growths—that is chondromas. The recent interest in them has been due largely to their intensive study by Drs Mixer, Barr, and Hampton, and their associates at the Massachusetts General Hospital.

The herniations from the intervertebral discs vary in position and frequently the extruded mass is not visible at once, even after laminectomy has been performed. With proper localization of the lesion before operation, extensive laminectomy is not needed, but usually the laminae that are removed are completely rongeué away, including the laminal portions of the articular facets. In special instances, with particularly well localized extrusions, unilateral laminectomy may be adequate, but, in most instances, complete removal of the fourth and fifth laminae is necessary to permit thorough exploration of the canal and to follow the course of the roots. After removal of these laminae the ligamenta flava will be seen as yellow bands crossing the dura. When their condition is pathological, they will be found not only greatly increased in thickness, but will show evident fibrosis with no clean line of cleavage between them and the dura, and will need to be dissected free. In such instances a transverse groove and indentation will be left in the dural canal. Under this, the dura is frequently very greatly thickened. Having resected the ligamentum flavum, both sides of the dural canal are carefully palpated, particularly along the area of the emergence of the spinal roots. A small nodule may be felt in relation to them, not infrequently, however, it will be difficult of detection. If so, the dura is opened, the filaments of the cauda equina are freed from their arachnoidal covering, and the interior of the dural canal is inspected. From its inner surface each root is observed and, only then, may a nodular protrusion be evident. Frequently it is of very small size—not more than from three-quarters of a centimeter to one centimeter in diameter—but will be seen compressing a nerve root as it emerges from the dural canal, and ordinarily the root so involved will be injected and edematous. The dura covering these protrusions will show an alteration

in appearance, small telangiectases being apparent.

When these masses are found extradurally, they are usually removable by the same route. At times the fibrocartilage will be lying free and only need be lifted out with forceps. At other times, it will have a fibrous covering which, when incised, will permit the white stringy material to be withdrawn, leaving a clean, smooth, shiny cavity from which a grooved director or probe will often pass directly down into the space between the intervertebral discs. At times the fibrocartilage may be extruded to considerable distances, and we have had the experience of finding a major part of it immediately beneath the laminae after their removal, compressing the dura from its dorsal aspect. This material had extruded from in front of the dura, passed around its side, and had come to lie beneath the laminae. Such an extreme protrusion is unusual. In the instances in which the mass is recognized only after the dura is opened, we have removed it through this transdural approach. A short incision over the mass will usually permit the material to be picked out readily, and the incision may be closed by a single silk suture. The incision in the posterior surface of the dura, through which the work has been done, is then completely closed (Figs. 5, 6, 7, 8).

When thickening and alteration of the ligamentum flavum are found, the ligament is completely dissected out, not only on the dorsal surface of the dura, but as it passes forward deep to the articular facets, and is cut close to its attachments to the intervertebral foramina. In most of our series of patients, the symptoms resulted from rupture of the intervertebral disc, a minority had gross and microscopic alterations in the ligamenta flava, and, in one, both conditions were present. From the anatomical studies it is apparent that the two conditions might well be associated and that a combination of alteration in the position of a portion of the intervertebral disc and a thickening of the ligamentum flavum, would enormously encroach upon the nerve in its groove.

With reference to the history given by these patients, their ages varied from 18 to 63



Fig 5 Transdural exposure of a displaced fibrocartilage

years, but most of them were in the active working period of life. A history of trauma caused by falls, bending, lifting, or torsion of the spine was given by the majority of patients, though in some cases, no history of trauma could be elicited. In still others, there was chronic repeated trauma, as in one woman who had done a great deal of horseback riding and jumping. In patients with rupture of the ligamentum flavum, trauma was consistently present and often the patient had felt a sudden snap in the back.



Fig 7 The appearance of a fibrocartilage after removal.



Fig 6 Transdural exposure of a herniated fibrocartilage compressing a root.

Most of the patients complained of both low back pain and sciatica, although the latter complaint was the more prominent. Relatively few had low back pain alone. As previously noted, these patients had had all manner of treatments with varying degrees of benefit but, in general, no lasting relief. It seems to us of particular interest that the symptoms may subside at times so that one frequently obtains a history of recurrent attacks, with periods of entire relief between them extending over a number of years.

With reference to the dislocation of a portion of an intervertebral disc, it must be appreciated that the clinical picture may vary greatly, depending on the amount and the location of the protruded material. We have seen sufficient extrusion of fibrocartilage to compress the entire content of the dural canal causing complete paralysis below the level of the lesion, loss of motor power in the sacral distribution, sensory loss and incompetence of the sphincters. Such a marked compression of the entire dural canal is unusual, and more often there is pressure on a single root. Sciatic pain is the most frequent and troublesome complaint. It may be aggravated by straining, coughing and sneezing, although this is not consistent. Usually the radiation of the sciatic pain is indicated as being down the outer side of the leg, extending into the foot on

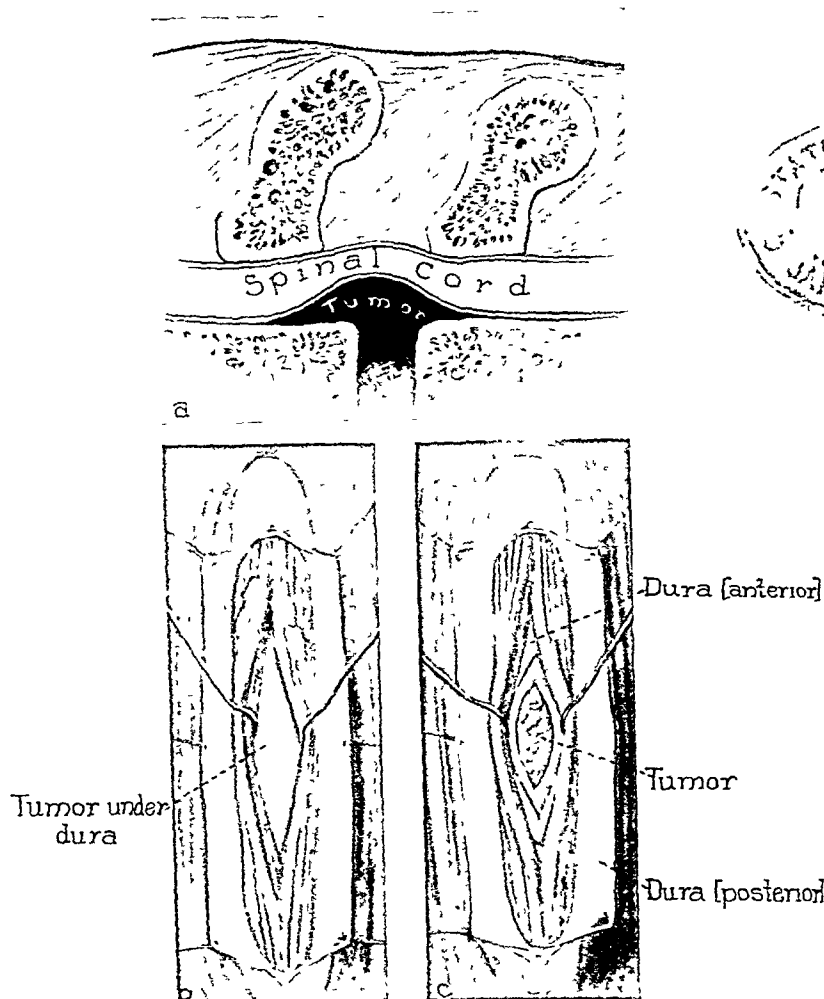


Fig 8 The cartilage extrudes backward and in the midline b Transdural exposure c Incision of the ventral dura to expose the mass

its dorsal surface Listing of the spine is common and may be marked In writings on the subject it has been stated that the list is commonly toward the side of the lesion, but very frequently we have found listing to the opposite side (Fig 9) An absent or altered Achilles reflex on the affected side is perhaps the most common objective finding The motor and sensory findings depend on the location and the structures compressed Ill defined sensory alterations over the outer side of the calf and the area supplied by the external

popliteal nerve are rather common, though sensory loss is not pronounced The muscles supplied by the external popliteal nerve may be weaker than those on the opposite side and, at times, there is a discrepancy in the degree of involvement of the tibialis anticus as compared to the extensor hallucis or the common extensors of the toes Atrophy in the peroneal muscles is seen in long standing cases, but the normal fullness over the belly of the tibialis anticus is rather commonly noted Movements of the back are limited and painful and



Fig. 9. Girl 18 years of age. List is away from the lesion.

the patients assume a variety of positions in sitting and lying in order to obtain comfort. Straight leg raising gives severe pain.

In the presence of such a history and the findings herein noted, particularly when there are objective evidences of involvement of a nerve root, compression by the dislocation of cartilage or the enlargement of the ligamentum flavum must be strongly considered. We have not ventured, however, to make a positive clinical diagnosis, or to operate without the aid of x-ray confirmation. In the final decision as to whether or not laminectomy is indicated, we lean heavily on the roentgenologist. His familiarity with the condition and his interpretation of the x-ray studies are of the greatest importance. Plain x-ray films are not diagnostic, although in certain instances there is some narrowing of the intervertebral disc on the affected side. Ordinarily, spinal puncture with the introduction of lipiodol is required. The puncture is usually done at as low a level as possible—usually between the fourth and fifth lumbar spinous processes. Occasionally, as the needle penetrates the dura and distorts it as it is pushed ahead, the patient will experience intense pain which follows the radiation of the root involved. It is exceptional for the dural canal to be so greatly encroached on or for the lesion to occur at a sufficiently high level to show any block-

age by the Queckenstedt test. We have, however, been able to reproduce the pain of which the patient habitually complains, by compression of the veins of the neck and increase in spinal pressure. In a considerable proportion of instances, the spinal fluid will show an increased total protein although the absence of such an increase does not speak particularly against lesions of the discs or the ligaments.

Lipiodol must be introduced in adequate amount—4 or 5 cubic centimeters. Following this, the patient is placed upon a tilting x-ray table in the face down or prone position and under the fluoroscope, the movement of the lipiodol in the canal is followed as, with the tilting of the patient, it is made to flow up and down the canal. If there is an irregular protrusion into the canal, the column of lipiodol will be found to bend around it, or to hesitate in passing it and often, by inclining the patient slightly to one side or the other, such an alteration may be exaggerated. Such findings are rechecked and final films are taken with the lipiodol about the point of obstruction. A lack of symmetry in the column of lipiodol, a constant notching at a level which corresponds to the root involved or the distortion of a root at its point of emergence from the dural canal, is considered diagnostic. In cases of doubt, the x-ray examination should be repeated at the end of 10 days or so. It is not uncommon for a second examination to give clearer diagnostic evidence. An hour glass constriction of the dural sac and the enclosed column of lipiodol has been seen in enlargements of the ligamentum flavum. Notching of the lipiodol column is more characteristic both of the protruded cartilage and the thickened ligament.

The results of laminectomy with the removal of the displaced cartilage or enlarged ligament, in relieving pain in the back, sciatica, and such neurological findings as may have been associated with them, have been excellent and attended with little risk. Certain questions are usually asked as to the effect on the back of the laminectomy itself and the use of lipiodol. Laminectomy in the low lumbar spine entails no disability for those not engaged in heavy physical work, though

some limitation in bending is present for a period of weeks. In relation to those who are engaged in doing heavy manual labor, the question is not so easy to answer. Some of our patients have returned to such work; others have been unable to perform the heavier parts of their duties, so that, in certain of the patients engaged in manual labor, laminectomy has been followed at the same stage by a bone graft

As to the use of lipiodol, this procedure is reserved for patients in whom the probability is strong that such pathological changes as we have described will be found. It has certain disadvantages and is not to be used indiscriminately. The most common complaint is of some discomfort referable to the sacral region and often a burning pain about the coccyx. When a condition is found warranting

operation, the lipiodol is entirely removed at that time. When the x-ray evidence has not been sufficient to justify operation, the lipiodol may cause discomfort for a considerable period of time.

The differential diagnosis between extrusion from the intervertebral disc and thickening of the ligamentum flavum is not easy to make, but the same surgical approach is required in both.

The patients discussed were among those who had been diagnosed as having some lumbosacral or sacro-iliac disorder which did not yield to such treatments as strapping, exercises, physical therapy, traction, and lumbosacral and sacro-iliac fusions. If temporary relief was secured, the episodes recurred. In such selected patients, lesions of the disc or of the ligamenta flava are frequent.

THE RELATION OF CHRONIC CYSTIC MASTITIS TO CARCINOMA OF THE BREAST

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IT is just a little over one hundred years ago that the first attempts were made to differentiate between benign and malignant tumors of the breast. In Lecture XIII, which appears in *The Principles and Practice of Surgery* written by Sir Astley Cooper and published in 1835, appears the following

The diseases of this organ have been too much considered as being of a malignant nature, and the females who have had the misfortune to have tumours in their bosoms have often been unnecessarily submitted to an operation under the idea of the complaint being cancerous. I shall therefore proceed to state what I have been able to learn from various diseases of the organ, to discriminate the malignant from the more benign complaints and to point to cases which really require removal in distinction from those in which the operation is entirely unnecessary.

Cooper gives the following account of pathological changes in a group of benign mammary conditions

A change in the nature of the swelling occurs as it enlarges. At first it is uniformly solid but afterwards distinctly divided into a solid and fluid part the latter fluctuating so as to inform the surgeon of the existence of fluid. If this part be punctured a liquid having the character of serum is discharged but the swelling soon becomes distended again and continues to grow. At length the tumour acquires enormous magnitude and some of the largest swellings in this organ are of the hydatid kind. I have twice seen swellings not of this description rather larger than the hydatid but generally the largest of the breast are of this kind. From Mrs King at Charing Cross I removed one which weighed thirteen pounds but frequently they are removed when still small under a supposition that they are scirrhous tubercles.

It is a complaint I have seen at all ages after twenty but more frequently in advanced age than in youth.

There may be some doubt as to whether many cases described by Cooper were cystic

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mastitis. Undoubtedly he recognized the disease, for he described over the fluid part of the cyst a slightly blue appearance. Thus, as far as we can determine, is the first mention of this feature, the significance of which Bloodgood has emphasized so much during the past years.

Brodie was apparently the first to recognize that the cysts originated in the milk ducts, and to attach some etiological significance to the absence of lactation. Lecture XXIV was published in 1846. It was devoted to cystic disease of the breast. The following appears in the published lecture

The disease of which I propose to treat on the present occasion is an affection of the female breast. It is one of general interest in various ways and among others in this that in its advanced stages it is liable to be confounded with carcinoma although it is not really of a malignant nature. I should not have been able to trace its exact history if I had trusted altogether to my hospital experience. I have not met with any description of it in text books corresponding to what I have observed of its actual progress. You will presently see how this is easily explained by the disease assuming a wholly new character as it proceeds so that if you were to look at two cases of it one in the early and the other in the more advanced stage without having witnessed the intermediate changes which have taken place you would scarcely be able to recognize their identity. Let me not, however, be misunderstood as to representing that no notice whatever has been taken of it by surgical writers.

The account which Sir Astley Cooper has given of the hydatid breast has been taken principally from cases of this disease and there have been allusions to it in the treatise on *Diseases of the Breast* lately published by Velpeau.

Brodie's contribution to cystic mastitis was the recognition of the age incidence and its frequent occurrence in women who had not lactated.

The observations made by Reclus deserve comment. They are as follows

The first characteristic is the extreme abundance of the cysts. Without doubt one would be able to

count by the naked-eye at least fifty, but microscopic examination shows innumerable cysts, not only in the tumor itself, but disseminated throughout the entire gland. The second characteristic is that in this specific disease one finds cysts in the acini and in the milk ducts, and in all the lobes and lobules. The third characteristic is the involvement of both breasts. The occurrence of tumors in both breasts is uncommon, but we have found in the cases which we have studied cysts in both breasts. It is perhaps because both breasts are affected that the lesion has been unrecognized as cystic in character. The disease very often is characterized only by irregularities on palpation, associated at times with but little pain. To the ordinary clinician the lesion might be regarded as a constitutional physiologic phenomenon.

This statement seems almost prophetic in light of the isolation of the ovarian hormones and the reproduction in animals by their use of the histological picture of cystic mastitis. Burrows, as will be shown later, has even suggested that the lesion be called estrogenic mastopathy.

Schimmelbusch gives the following description of the disease bearing his name:

Cyst adenoma mammae (*Maladie kystique*) is a disease which is not uncommon in middle aged women. It occurs with equal frequency in those who have and have not borne children. Numerous cysts the size of a pea or bean, rarely larger, develop. These are filled with greenish-brown, somewhat sticky fluid, and are found especially in the posterior part of the gland. The diseased breast is not adherent to the neighboring structures. The disease affects almost without exception both breasts at the same time, or one shortly after the other. Microscopically there is found a marked increase in the number of acini. The epithelium may undergo slight hyperplasia or form a cast of the alveolus. Two or more acini may fuse, and as a result of the poor nourishment of the epithelium cysts may form, the contents of which are a combination of secretion and degeneration. The connective tissue shows no evidences of inflammatory or proliferative changes. It is known, however, that a carcinoma may develop upon this disease, for among 43 cases, a carcinoma of the breast was found three times.

Nature Numerous names have been given to diseases of the breast characterized by cyst formation. These are all based upon histological peculiarities. There is no need to recall all, such as senile parenchymatous hypertrophy, cystiphorous desquamative epithelial hyperplasia, and fibro-adenomatosis cystica mammae. The terms are based largely upon the anatomical findings, and suggest no etio-

logical relationship to glands of internal secretion, although there has been abundant evidence to show that a distinct relationship exists between ovarian function and the breast. The mechanism by which the activities of the ovaries, uterus, and mammary glands are regulated, co-ordinated, and synchronized is fairly well understood at the present time. The idea which formerly prevailed, that the changes which occurred in the breast during pregnancy were due to nervous influences, has been shown to be wrong. Clinically changes are frequently observed in the breast during the menstrual cycle; most frequently before menstruation begins. The woman complains of a sense of fullness of the breast and some tenderness. Upon palpation a granular, flattened mass, which disappears when menstruation begins, may be felt. Definite changes in the breast during the menstrual cycle have been described. Differences of opinion there may be as to the interpretation of these changes, but all agree that changes do occur which are correlated with the different phases of the menstrual cycle. The isolation of the different ovarian hormones has made it possible to study the changes produced in the breast when the hormones are introduced into the circulation.

The conclusions arrived at by Burrows in an article recently published entitled "The Pathological Changes Induced in the Mammæ by Oestrogenic Compounds" are as follows:

- 1 The earliest pathological effect of estrin observed in the mammæ of male mice is a proliferation of the mammary ducts, that is to say, gynecomastia. This proliferation of ducts is occasionally accompanied, especially when the treatment has been prolonged, by the formation of what look like clusters of acini.

- 2 Speedily following the proliferation of ducts is their dilatation with the formation of mammary cysts.

- 3 The next stage is that of hyperplasia of the epithelium lining the ducts; sometimes accompanied by an increase of the periductal stroma. This stage of hyperplasia, combined with the presence of cysts, represents the chronic cystic mastitis of the old and the "cystic mastopathy" of the new terminology. In view of its causation, it might perhaps better be termed "estrogenic mastopathy." In advanced cases epithelial anaplasia may be seen in the ducts. All the foregoing changes are produced by estrin, in the same sequence in both male and female mice.



Fig. 1 A whole mount of the breast of a castrate female rat showing the production of cystic disease. This rat received 100 gamma of estrin for twenty days beginning with the twenty first day of life. The specimen was taken 5 days after the last injection.

Recent studies by Astwood, Geschickter, and Rausch have shown that during the first 6 weeks of life the mammary gland develops independently of the ovary or testis, and that the gland enlarges with equal rapidity, whether the gonads are present or not. The breast of the normal female possesses no lobules or acini except during pregnancy but shows periodic secretory changes recurrent with the estrous cycles. The manner in which estrin modifies mammary development is dependent upon the dosage, the age of the ani-

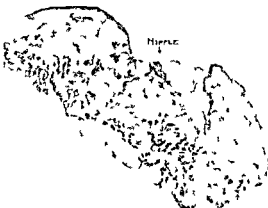


Fig. 2 Whole section from the breast of a case of adenosis. The lobular development is reduced in amount. There is increased fibrosis and the terminal tubules at base of gland show irregular hyperplastic epithelial changes.

mal, and the state of nutrition. During the first 2 weeks of life, estrin causes no demonstrable changes. After the age of 3 weeks, estrin in small or moderate doses accelerates the extension of the duct tree. Large doses cause a stunted type of growth, with irregular widened ducts, distorted tubules or end bud proliferation. Continued high doses cause secretory changes which are initiated with cyst formation. The gland becomes prematurely aged, the hyalinized connective tissue is increased in amount, and marked changes in the ducts are noted.

The changes which have just been described are not unlike those seen in Schimmelbusch's disease. As has been stated, large cysts are not usually found in this disease, but a widespread transformation of the parenchyma into small cysts, associated with epithelial overgrowth, occurs.

Classification. Notwithstanding the amount of work that has been done upon cystic mastitis, there is still a lack of uniformity of opinion as to how some phases of the process should be classified.

A number of different names, such as papilloma intracanalicular, duct cancers, cystadenoma papillare, carcinoma villosa and cyst epithelioma intracanalicular have been given to the papillomatous growths which are encountered in the medium sized and large ducts. Many different views have been expressed

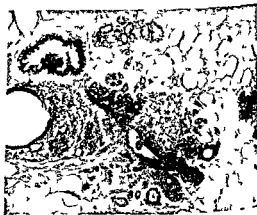


Fig. 3 High power photomicrograph of the epithelial changes in the case shown in Figure 2. Normal lobule formation is being replaced by non-encapsulated adenomatous changes in the region of the terminal tubules.



Fig 4 Gross specimen showing characteristic tissue removed from a case of multiple blue dome cysts. The smooth walled cyst is surrounded by dense fibrous tissue

concerning the relation that these may bear to cystic disease of the breast.

Koenig believed these to be true tumors which differed from and were not related to the epithelial proliferations noted in cystic mastitis. Tietze, on the other hand, thinks that the papillomatous growths observed in cystadenoma mammae are a part of the change and of the same nature, and ascribed to them a rôle in the development of cancer in cystic mastitis. Semb believes that the occurrence of multiple papillomas in cystic mastitis, their frequency and the histogenic analogy with the development of the disease render it necessary to regard the two processes as being closely related to each other, and concludes that the cystadenopapillomas must be conceived of as being formations belonging to the picture of cystic fibro-adenomatosis, or a part of that condition and connected especially with the later stages of that disease.

Certain papillomas appear as independent tumors. Many emphasize the relationship between these and carcinoma. Such papillomas are usually large, solitary growths and are not associated with the mammary changes seen in cystic disease. It will be seen from the above that there is no uniformity of opinion as to the nature of the small multiple papillomatous

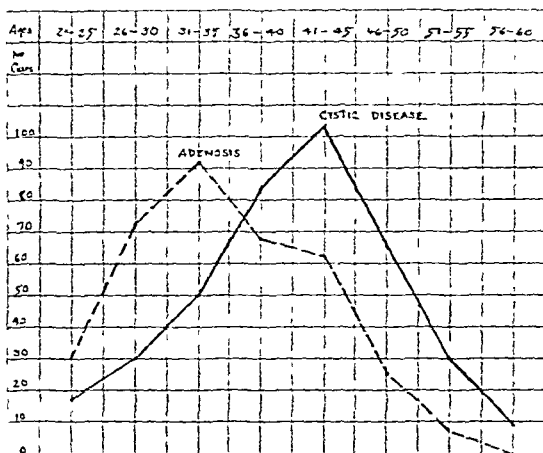


Fig 5. Chart showing the relative frequency and the age incidence of adenosis and cystic disease

growths. Multiple papillomas do not seem to occur as a true tumor, but develop as the result of epithelial changes in cystic disease, and should be regarded as a part of the diseased process. Whether or not they are precancerous, or are liable to undergo malignant changes, will be discussed later, when the clinical histories of cases of cystic disease followed by us are discussed.

As one's experience with cystic mastitis increases, many lesions that were formerly regarded as malignant are placed in the benign group. The following indicates how Bloodgood changed his opinion over a period of a few years. Cases will be cited from the Johns Hopkins Clinic which will indicate how a change in the classification of lesions of this type has occurred as the specimens and the results have been restudied and correlated.

As an example, Bloodgood in 1904, basing his opinion upon microscopic examination alone, concluded that malignant epithelial change occurred in 10 per cent of all cystic disease. In 1906, he wrote that adenocarcinoma was already present in 50 per cent of the patients with adenocystic disease that he had examined. In 1921, he reported his experience with 350 cases of cystic disease in 128 of which the treatment had been local excision only. A follow-up showed that carcinoma had developed in 3 of these cases—an incidence of 2.3 per cent.



Fig 6 Photomicrograph of a small tumor removed from the breast of a patient of Dr Halsted's in 1897. The lesion was diagnosed microscopically as adenocarcinoma and the complete operation was performed. There were no metastases to the lymph nodes and the patient remained well for a period of more than 16 years. This lesion on restudy has been reclassified as benign.



Fig 7 Photomicrograph of a non-encapsulated adenoma, diagnosed adenocarcinoma from the biopsy performed in 1913. The complete operation was performed. The lymph nodes show no metastases and the patient was reported well 8 years later. This lesion also on restudy has been reclassified as benign.

Difficulties of making a diagnosis, both microscopic and clinical, are encountered in certain types of cystic mastitis. A study of some cases which have been observed in the Johns Hopkins Surgical Clinic will illustrate the difficulties and account for the change in opinion which has been made from time to time. Clinically intermittent retraction of the nipple has been observed. The following clinical note appears in the paper by Bloodgood upon "The Pathology of Chronic Cystic Mastitis of the Female Breast." The patient, examined by him in 1912 presented a variation in the clinical picture which he had observed once since, that is intermittent retraction of the nipple as a symptom of onset with induration of the breast chiefly in the nipple and areolar zone.

The patient a white unmarried woman aged 38 had intermittent retraction of the left nipple for 4 years and permanent retraction for 4 months while she had observed intermittent retraction of the right nipple for 4 months. On inspection both nipples seemed retracted on palpation the left nipple remained retracted while the right nipple bulged. There was an indefinite induration beneath both nipples. He performed the complete operation on the

left breast and then 3 weeks later, removed the right breast and then 6 months later removed the glands in the right axilla. The operation on the right breast was an illogical one but at my first pathologic examination I interpreted this case as an adenocarcinoma in chronic cystic mastitis. The patient was well 9 years later.

On pathological examination a non-encapsulated cystic adenoma was found beneath both nipples. The small, solid adenoma infiltrated the fat.

The following is the history of another patient who had an intermittent retraction of the nipple of 18 months' duration. When examined in 1912 the nipple was permanently retracted.

The patient was a widow aged 49 years. She had observed that the nipple of the left breast retracted and protruded on and off for 18 months. There had been no discharge from the nipple. She sought advice because of pain of 4 months' duration. On palpation nothing very definite was made out. The breast was explored and it was thought that there was a carcinoma just beneath the nipple. A radical operation was performed. In the laboratory a zone of non-encapsulated adenoma was found just beneath the nipple. The surrounding breast tissue was fatty and senile. The diagnosis was small, irregular stellate adenoma with some cystic adenoma. No metastases were found in the lymph nodes.

The patient returned 2 years later with a similar clinical picture in the right breast—intermittent retraction of the nipple of 1 year's duration, permanent retraction for the last 3 months. On palpation indefinite lumps were discovered in the breast. Because the diagnosis of adenocarcinoma in chronic cystic mastitis was still unchanged, a complete operation for cancer was performed. The gross and microscopic pathology of this breast was practically identical with that of the breast removed at the first operation.

Here are recorded 2 cases of chronic cystic mastitis with intermittent retraction of the nipple, and in each both breasts were finally involved.

Nine of 18 specimens (50 per cent) of non-encapsulated cystic adenoma in the cases studied by Bloodgood were removed at the Johns Hopkins Surgical Clinic. Only 1 of these showed microscopically fully developed cancer. All, with the exception of one, were at once or later subjected to the complete operation. During the same period, about 30 years, 9 specimens were sent to Bloodgood for diagnosis. These 9 specimens were sent by surgeons in 9 different states. This indicates that the lesion is rare, excites interest, and that pathologists disagree as to benignity and malignancy. A radical operation was performed immediately or later upon these patients. No metastases were found in the nodes. All have been followed. There have been no recurrences in this group and none has died of cancer. Bloodgood concludes, after studying this group of cases:

I am confident that it is this group of cases that has given rise to the impression that it is not dangerous to excise a malignant tumor of the breast, submit it to microscopic study, and then perform the complete operation for cancer some days or weeks later. This type of tumor, when diagnosed adenocarcinoma, increases the percentage of cures of cancer, not only in this group but the total percentage of operative cures of cancer of the breast. When these cases and some of those in group B B 13-8 were included in our cases of cancer of the breast they increased the percentage of five-year cures. When all cancers of the breast without metastases to the nodes and these two groups with the comedo-adenoma were included the percentage of five-year cures was more than 80. When these three groups were excluded the percentage of cures dropped to 60.

Bloodgood closes his article upon "The Pathology of Chronic Cystic Mastitis of the

Female Breast—Where Pathologists Disagree" with the following:

I have submitted sections of every type of chronic cystic mastitis, lactation mastitis, tuberculous mastitis, encapsulated cystic adenoma, fibro-adenoma, and intracystic papillomas to more than forty consulting pathologists, and I have their written diagnoses. In the majority of these there was some disagreement; the percentage of those favoring benignity varied from twenty to ninety.

In all of these demonstrations the sections illustrated in Figures 87 and 89 were included. On these 2 cases of fully developed cancer there was not a single disagreement.

During the same period many sections and tissues have been sent to me from other surgeons and pathologists with their diagnoses. I have never received one which proved to be a fully developed cancer that had not been diagnosed cancer. But I have received many with a diagnosis of cancer which, in my opinion, belonged to one of the above mentioned benign groups.

It is very interesting to record here again that in breast lesions, when good pathologists disagree as to malignancy, the patient lives; when there is agreement, there is always a large percentage of deaths from cancer.

EFFECT OF PREGNANCY AND LACTATION

Experimental work which has been cited indicates that there is a definite relationship between the ovarian hormones and cystic mastitis. It will be interesting to record the effects of pregnancy and lactation upon the breast when a diagnosis of cystic mastitis has been made. Sterility is not uncommon when this lesion exists, and we have had an opportunity to follow but a few cases. The history of four will be given.

McC. The patient, a white female aged 32 years, had had two children, the youngest being 10 years of age. In April, 1934, one ovary and two-thirds of the opposite ovary were removed because of cysts and the patient was told that no further pregnancies were probable. Following the operation, pain more pronounced in the premenstrum was noted in both breasts. The patient was first seen in November, 1935. At this time nothing abnormal was palpated in either breast but the pain had become continuous and there was mild galactorrhea. Cancer was feared. The patient was given reassurance that her condition was not cancerous and told to return in 6 weeks. When the patient returned in 1936 pain in both breasts had become constant. The menstrual periods had become irregular and the cycle was shortened to 21 or 26 days. At this examination indurated masses were found in the outer upper quadrants of both breasts. Definite masses were present in both breasts.

about 1 centimeter in diameter. One in the upper half of the left breast and one in the outer upper quadrant of the right breast. The breasts were shotty and had a definite edge. No hormones were given but the patient was told to return for treatment. She did not come back however for over a year.

The patient was next seen April 3, 1937. She was now 4 months pregnant. The pains in the breasts were now intermittent but sharper and more stabbing since pregnancy. On examination a definite edge could still be felt in the left breast and the nodule persisted in the left breast but not in the right. In the right breast an indefinite dense mass was palpated in the outer upper quadrant. There were no lumps and no definite edge. No treatment was prescribed. The patient was told to return in 3 weeks.

The patient was seen April 23, 1937. She is now 5 months pregnant. Pain has disappeared, the breasts are enlarged, and no masses can be felt in either breast. She was followed until after delivery when both breasts were normal to palpation.

D. H. The patient is a white female, aged 29 years, who is married but childless. She has had trouble with her right breast over 4 years. In 1925 she first noticed tenderness and a small mass about 2 centimeters in diameter in the lower inner quadrant. Recently a small tumor appeared to the outer side of last mentioned tumor. Both were small, smooth and cystic to palpation, when examined in January 1929.

In June 1929 the patient became pregnant. Both breasts increased rapidly in size at the end of the first month and from then on the tumors could no longer be palpated and no tenderness was noted. Following the birth of her first child in March 1930 the breasts have remained negative. She had a second child in August 1932 and when last heard from in October 1936 she had remained well.

E. K. The patient is a white female, aged 27 years, who is married but has no children. Her menstrual periods are regular. About 4 years ago severe pain was noted in both breasts before her periods. At first this soreness lasted for 1 week before periods. It is now nearly continuous. Four months ago a lump appeared in the right breast. The patient received sixteen injections of anterior pituitary like hormone and small doses of estrin (250 international units per c.c.) elsewhere. The tumor regressed under treatment but the pain was not affected and the patient was advised to have her breast off.

When seen in January 1936 the right breast was larger than the left but the breasts were otherwise normal to inspection. The left breast has a definite edge on palpation and is diffusely shotty or lumpy, particularly in the outer and upper quadrant. The right breast also has a definite edge but has a large flat dense area about 4 centimeters in diameter in the outer and upper quadrant. The region where the former lump was felt, the inner lower quadrant, is now negative.

The patient received 40,000 international units of estrin in January, 1936. Thereafter she received 10,000 international units once a month. The breasts

have remained free from tumors and free from pain since the second month of injections. She was seen in January 1937, and both breasts were negative at that time. In June 1937, there was some return of premenstrual pain. This was followed by rapid enlargement of both breasts and an Aschheim-Zondek test revealed that the patient was pregnant. She was seen August 20, 1937, when she was 3½ months pregnant. At this time both breasts were uniformly enlarged, tense, and free from nodules and pain or tenderness. In the last third of pregnancy the breasts softened and were negative to palpation.

Mrs. L. A. W. The patient is a white female, aged 33 years, married but childless. Her menstrual periods are regular. She has had trouble with her breasts for at least 10 years. In 1925 an operation was performed for the removal of a tumor from the right breast. In 1929 a tumor was removed from the left breast. In November 1932 tumors were removed from both breasts through incisions along the lateral borders of the breast. The lumps and fear of carcinoma have been the most pronounced feature of the case. The patient has recently gained weight. She has always been nervous and has a constant fear of cancer.

Examination shows two relatively small and misshapen lumpy breasts. Scars and tumors are found in both breasts. The largest lump is in the outer lower quadrant of the right breast and above this there is dimpling due to the former incision. There is no discharge from either nipple. At least eight small cysts can be palpated in the right breast, the majority in the middle of the upper half. There are four cysts in same location of left breast and two in lower outer quadrant. Multiple small cyst like tumors can be palpated at periphery of both breasts.

The patient received estrin therapy in November 1935—35,000 international units. The symptoms were somewhat improved in February, 1936. Patient has been free from pain but the cyst still remained in October 1936. In May 1937 the patient became pregnant and she has become less conscious of the lumps in her breast. These have not bothered her since the second month. The patient was asked to return for examination during pregnancy but because of the illness of her mother she did not do so. In November 1937 her breasts were examined by her obstetrician who sent the following report.

The patient is now 7 months pregnant. The right breast is negative except for a small nodule about 2 centimeters in diameter just above the nipple. The left breast is also negative except for a small mass 1 centimeter in diameter in the upper inner quadrant. Both nodules are not tender and are not attached to the skin or surrounding tissue.

CRITERION FOR ESTABLISHING RELATIONSHIP TO MALIGNANCY

Those studying the relation of malignancy and chronic cystic mastitis may be divided

into two groups. One group considers cystic mastitis a benign lesion with no etiological relationship to carcinoma, the other, a benign lesion but precancerous in nature. The group which regards the lesion as benign without malignant potentialities base their opinions upon clinical examinations and a careful, prolonged follow-up of patients operated upon and observed clinically over a long period. There are certain borderline cases, the nature of which has not been recognized. Not infrequently these have been regarded as malignant. The clinical behavior of such cases, however, has not justified the conclusions based upon histologic examination.

Campbell has followed a large number of cases clinically and he concludes:

One may approach the problem with the easy philosophy that total removal of the breast will for all time relieve the patient of worry and risk, the surgeon of responsibility. However, it is assumed that preservation of the breast, both from a functional and a cosmetic standpoint, is desirable and commendable if it can be accomplished with reasonable safety to the patient.

From the standpoint of risk of malignant change, there is no more justification for amputation of the breasts than for the routine removal of normal breasts to prevent the inevitable occurrence of cancer in approximately 2 per cent of the cases.

We have records of 1,048 cases of chronic cystic mastitis, of which 375 were cases of early adenosis — Schimmelbusch's disease. Two hundred seventy of the 375 patients were not operated upon; 105 were. Seventy excisions were performed and 35 radical removals, 9 of which were bilateral. Among the cases in which operation was not done or in which simple excision was performed, 76 have been followed 10 or more years. But two of these patients are known to have died of carcinoma originating in the breast. Eighteen died of other diseases during the period of follow-up.

In a second group are 158 cases of advanced adenosis. No operation was performed upon 57; a simple excision upon 57; radical removal of the breast upon 44; and in 9 of these both breasts were removed. Of these 158 cases, 97

TABLE 1.—ULTIMATE RESULTS IN 1,048 CASES OF CHRONIC CYSTIC MASTITIS

Adenosis	Cases	Cystic Disease	Cases
No operation	327	No operation	54
Early (operation)*	105	Simple cysts (operation)	386
Advanced (operation)	101	Multiple cyst (operation)	75
	533		515
Followed more than 5 yrs	271	Followed more than 5 yrs.	252
Died of breast cancer	3	Died of breast cancer	1

*With few exceptions the operations performed in these cases were simple excisions.

have been followed for a period of more than 5 years. But one of these is known to have died of a cancer originating in the breast—an incidence of about 1 per cent.

In the series are 515 cases of cystic disease. In 54 of these an operation was not performed. Simple excision was performed 395 times and radical removal of the breast 66. Two hundred and fifty of these have been followed more than 5 years, and of these but one has died of carcinoma of the breast originating in the breast — an incidence of 0.4 per cent (Table I).

Tissue from 2,675 carcinomas of the breast has been examined. In but 29 did the surrounding tissue show any well developed areas of adenosis; in 3 cystic disease was found. Less than 0.5 per cent of the changes found in Schimmelbusch's disease are found in the ordinary type of carcinoma of the breast, but approximately 30 per cent of comedo or duct carcinoma show histologically a relationship to adenosis (Schimmelbusch's disease).

These figures would seem to indicate that cystic disease and adenosis are not precancerous lesions, and that radical operations should not be performed as frequently as they are. Another form of therapy should be tried. Reclus' statement seems to be almost prophetic: "For we may finally conclude that the disease is really dependent upon some constitutional physiologic phenomenon." It seems that in chronic cystic mastitis the epithelial changes have been carried almost to the point of lactation, which is not reached. If lactation had occurred these changes would have disappeared during involution of the breast.

IMMEDIATE OR DELAYED TREATMENT OF ACUTE CHOLECYSTITIS

Liver Shock and Death

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IT REQUIRES sound judgment to choose the opportune moment for surgical intervention in acute cholecystitis. Any attempt to standardize the time of operation in all cases is hazardous. In acute inflammatory disease of the gall bladder, as in acute hyperthyroidism, care in judging the individual case is of the utmost importance, if operative mortality and postoperative complications are to be kept at a minimum.

In the past 10 years considerable controversy has arisen as to the ideal time to operate, the recent literature on this subject has frequently been vague as to the definition of immediate or emergency operations and by no means explicit as to what is meant by an early operation. The purpose of this paper is to help clear up some of the confusion that exists, in order that we may more clearly interpret these terms. Certain beneficial pre-operative measures will be emphasized, and a postoperative complication termed "liver shock and death" will be discussed.

The idea must be clarified that immediate or emergency operations are synonymous terms. An early operation implies an interval of from 24 hours to 7 days, while delayed or late procedures indicate that the acute process has been allowed to subside, and the gall bladder is removed some weeks or even months later.

The recent trend toward earlier interference in acute cholecystitis has had a stimulating effect upon the leading surgeons of our country and abroad. Their opinions have been quite firm, but show a surprising lack of unanimity. At first glance one feels that their arguments are equally convincing, but on second thought, hesitates to take a definite stand without analyzing the situation more carefully.

The "immediate" group. A J. Walton, a noted English surgeon, as early as 1913 emphatically advocated immediate interference. He decried the fact that surgeons universally have agreed that acute appendicitis should be treated at once yet are reluctant to operate as emergencies on those patients who are suffering from acute cholecystitis. He emphasized that if the operation is carried out in the early stages, severe complications such as gangrene with perforation may be entirely prevented. He also points out the fact that the maneuver is facilitated by the edematous state of the tissues, and that if the operation is performed at a later stage the technical difficulties are increased.

Leriche and Cotte in 1918 advocated immediate cholecystectomy, and it is surmised from the article reviewed that the present tendencies in France are for intervention without delay.

Graham urges prompt operation. In a group of 198 consecutive cases, 20 patients were operated upon within 48 hours of the onset of the acute symptoms, with a mortality rate of 5 per cent, the remaining patients who were operated upon after the 48 hour interval suffered a mortality of 62 per cent. The single death in his first group was due to pancreatitis. Although his contention may be valid, it does not seem that there are sufficient numbers in the immediate group to warrant definite conclusions. He enumerates various reasons for immediate operation, the most important of which are:

1. No deaths followed early operations when acute cholecystitis was the only disease present at the time of the operation.

2. The necessary operations were simple ones.

3. Postoperative complications were few. He observes further that operations from 1

From the Surgical Service, The Roosevelt Hospital.
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to 34 days after admission to the hospital showed that:

1. Mortality was increased and in many the deaths were attributable directly to the delay.

2. Longer and more difficult operations were necessary.

3. The number of postoperative complications was greatly increased

Stone and Owings in a concise and enthusiastic manner approach the problem other than statistically. They suggest that, if it is a sound principle to remove immediately an inflamed appendix, or to suture immediately a perforated peptic ulcer, it is logical to treat acute lesions of the gall bladder in the same manner. They admit certain anatomical differences between the gall bladder and the source of more extensive and gross soiling than a leak in a distended gall bladder. They state that "anyone who realized the amount of infectious material that a diseased gall bladder may contain will not be inclined to underestimate the possibilities of contamination that its rupture may entail."

My own contention is that the acutely inflamed gall bladder but rarely perforates into the free abdominal cavity causing a diffuse peritonitis. The majority of perforations of this viscus occur so gradually that protective adhesions between the gall bladder, omentum, and colon are formed, and usually result in a localized abscess.

Stone and Owings are unconvinced of the argument that operations in the acute stage require greater skill and judgment than operations on the subsiding gall bladder. They think it is unworthy to compromise a principle of treatment on account of the lack of skill in the profession.

Finney, a reliable and conservative surgeon, believes in immediate operation. Heuer, in a most painstaking statistical and rationalized presentation, should be placed in this group of immediate operators. He gives a series of 153 cases, 65 per cent of which were subjected to operation the day of admission, 35 per cent being observed 48 hours or more before operation was performed. He feels that 20 per cent of all cases of acute cholecystitis are complicated by gangrene and perforation. He confesses that he does not operate

upon every case as an emergency; for operations have been deferred where pre-operative treatment seemed advisable.

The "early" group. From a careful study of the literature, I am impressed with the fact that the majority of surgeons can be classed in this group of so-called "early operators," who do not advise operation at once.

A valuable statistical contribution in favor of "early operation" (48 hours to 7 days) is that of Branch and Zollinger. In their study of 235 histories of patients admitted to the Peter Bent Brigham Hospital in Boston, they found 34 or 14.4 per cent were operated upon immediately for reasons of definite signs of peritonitis or of an impending perforation, with a mortality of 20.3 per cent; the remaining 195 patients were treated conservatively for an average of 4.7 days before operation, with a mortality of 8.7 per cent.

Many of the authors writing upon this subject have referred to Judd and Phillips as strong advocates of immediate intervention. When their article is carefully studied it is of interest to note that only 14 times in a series of 508 cases was an operation performed as an emergency measure. It is also of interest to note that in 68 of these cases the wall of the gall bladder was gangrenous; and in 61 of these 68 cases, it had perforated, with the formation of an abscess on 38 occasions. This shows that in over one-half of the cases in which the gall bladder was perforated, the lesion had walled off into a localized abscess, and only in three had the gall bladder ruptured into the general peritoneal cavity with an ensuing diffuse peritonitis. It seems to me that these statistics show that perforations of this viscus into the general abdominal cavity are relatively infrequent, as compared to that many cases (508) of acute appendicitis.

Once again the term "early" has been confused. Many of the investigators interested in this particular disease have classified Judd and Phillips as "immediate" operators, when in reality they must be placed in the "early" group.

The operative mortality in the group studied by Graham of Toronto, showed that in the group of patients operated upon immediately there was 16 per cent mortality, while

IMMEDIATE OR DELAYED TREATMENT OF ACUTE CHOLECYSTITIS

Liver Shock and Death

HENRY W. CAVE M.D., F.A.C.S., New York New York

IT REQUIRES sound judgment to choose the opportune moment for surgical intervention in acute cholecystitis. Any attempt to standardize the time of operation in all cases is hazardous. In acute inflammatory disease of the gall bladder, as in acute hyperthyroidism, care in judging the individual case is of the utmost importance, if operative mortality and postoperative complications are to be kept at a minimum.

In the past 10 years considerable controversy has arisen as to the ideal time to operate, the recent literature on this subject has frequently been vague as to the definition of immediate or emergency operations and by no means explicit as to what is meant by an early operation. The purpose of this paper is to help clear up some of the confusion that exists, in order that we may more clearly interpret these terms. Certain beneficial pre-operative measures will be emphasized, and a postoperative complication termed "liver shock and death" will be discussed.

The idea must be clarified that immediate or emergency operations are synonymous terms. An early operation implies an interval of from 24 hours to 7 days, while delayed or late procedures indicate that the acute process has been allowed to subside, and the gall bladder is removed some weeks or even months later.

The recent trend toward earlier interference in acute cholecystitis has had a stimulating effect upon the leading surgeons of our country and abroad. Their opinions have been quite firm, but show a surprising lack of unanimity. At first glance one feels that their arguments are equally convincing, but on second thought, hesitates to take a definite stand without analyzing the situation more carefully.

The "immediate" group A. J. Walton, a noted English surgeon, as early as 1923 emphatically advocated immediate interference. He denied the fact that surgeons universally have agreed that acute appendicitis should be treated at once yet are reluctant to operate as emergencies on those patients who are suffering from acute cholecystitis. He emphasized that if the operation is carried out in the early stages, severe complications such as gangrene with perforation may be entirely prevented. He also points out the fact that the maneuver is facilitated by the edematous state of the tissues, and that if the operation is performed at a later stage the technical difficulties are increased.

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writers. He quotes Heller as postponing the operation until the interval. There are other German surgeons, among them Enderlen and Hotz who 14 years ago found that the mortality following operations performed during the acute attack was double the mortality following procedures carried out during the remission.

Unquestionably a certain number of patients will not submit to immediate or early operation and in consequence endanger their lives by the sequelæ which follow gangrene and perforation.

Liver shock and death. Heyd in 1924 described an unusual complication following surgery on the gall bladder and biliary tract. There were certain unexplained fatalities which focused his attention upon the possibility that these deaths might be due to some form of liver disturbance. Thus the term came into use "liver shock and death." He divided these fatalities into three types.

1. The patients suffering from chronic cholecystitis with jaundice. Following operation they fail to regain consciousness and, with a rapidly rising temperature and markedly increased pulse rate, die within 36 hours.

2. Those suffering from obstructive jaundice. Following choledochostomy with drainage they progress satisfactorily for several days, then without any known exciting cause become delirious, and gradually lapse into coma. The escaping bile becomes less in amount and watery in color and consistency.

3. A rare condition. The patients with a diseased pancreas and bile ducts, without jaundice. After choledochostomy with drainage they appear to be progressing satisfactorily when suddenly there is a marked acceleration of the pulse rate, a fall in blood pressure, a suppression of urine, and a condition exhibiting signs of collapse; but occurring much later than is usually seen in shock which ordinarily follows cholecystectomy.

In 1926 the essayist (4) reported 3 patients who died within 40 hours after operation with immediate hyperpyrexia. One had a temperature of 107.2 degrees, another 106 degrees, and still another 107 degrees. Hemorrhage, peritonitis, pneumonia, and embolism were ruled out clinically. These were cases of chronic cholecystitis with cholelithiasis, and a chole-

cystectomy had been performed. None was jaundiced. The operations were performed without difficulty, in fact 2 were noted as having been extremely easy; all 3 were drained. It seemed that immediately after the operation was finished the temperature began to rise with an accompanying rapid pulse. Although no mention was made of liver traumatization, except in one instance, we believe that these patients died from absorption of either diseased or chemically altered liver cells, or toxic bile.

Payne, in an article recently read before the American Medical Association, endeavors to explain and to offer remedies for this bizarre complication. He states that if the common bile duct has not been drained it seems logical to fall back upon blood chemistry determinations of xanthoprotein, indican, and cholesterol esters. It has been shown that in severe liver damage and especially in hepatic coma xanthoprotein in the blood is high and blood indican low; this is different from the blood study of uremia where xanthoprotein is high and indican is high. He quotes Epstein as observing that in liver death there is marked lowering of the numerous relations between the cholesterol esters and the total blood cholesterol; also that a steady rise in cholesterol esters signified a favorable outcome.

The late Lord Moynihan reported a liver death which he felt followed ligation of a branch of the hepatic artery; ischemic necrosis of a large area of liver substance resulted; it was thus presumed that absorption of devitalized liver cells produced an overwhelming intoxication. There are many who have supported this view as the primary cause of all "liver deaths."

It has been demonstrated (18) experimentally in dogs that the clinical course of "liver death" and similar liver changes has followed ligation of the hepatic arteries; in the animals that did survive there was found adequate collateral circulation to all lobes of the liver, and absence of hepatic necrosis. Thus a pathologically descriptive term has been applied, "acute postoperative necrosis of the liver." From experimental investigation and from clinical studies (1), the following hypotheses have been offered:

in the "early" group it was only 4.8 per cent

Smith, some years previous to the publication of his paper in 1933, had no hesitancy in operating immediately, even though there was an elevation of temperature, and the patient was desperately ill. He changed his opinion rather abruptly following the death of an obese woman aged 53, upon whom a partial cholecystectomy during the acute stage had been done. In the records of the St. Luke's Hospital in New York, he found that 107 patients operated upon in the acute stage showed a mortality rate of 9.3 per cent while in a group of 94 patients who had been allowed to subside, 5 died with a 5.3 per cent mortality rate.

Recently a study of 300 consecutive cases of clinically acute cholecystitis was made by Pennoyer of our surgical staff at The Roosevelt Hospital. All of these patients had an elevation of temperature, abdominal pain, many of them had nausea and vomiting, accompanied by abdominal distention. All had rectal temperatures of 101 degrees or over with a leucocytosis of 12,000 or over.

His cases were selected as clinically acute ones to ascertain whether or not the management and the mortality rates were comparable to other groups studied. During this investigation he noted that only one half of the cases reported acute by the pathologist could be considered acute clinically. This was particularly noticed in the edematous, distended enlarged gall bladder with other signs of acute inflammation, where acute attacks were superimposed upon a chronic inflammatory process.

The most serious complication of acute cholecystitis is gangrene and perforation. I admit that it is much commoner than the textbooks of the older writers record but do not believe it is as frequent a complication as had been intimated recently, and consider it to be less serious than those which will ensue if cholecystectomy is to be performed routinely in the acute stage by the surgeon of average ability. Practically 90 per cent of patients acutely ill with clinical manifestations of acute cholecystitis will subside. It is striking to note the smooth convalescence of patients operated upon when gangrene, perforation and local

ized abscess have ensued. There were 30 deaths in The Roosevelt Hospital series of 300 consecutive cases—a mortality of 10 per cent. It is significant to note that half of these deaths occurred in the small group of 59 patients who were operated upon as emergencies. When the mortality rates are rearranged it is observed that immediate operation in our hands gives a mortality rate of 20 per cent while in the remaining group the rate is 5 per cent.

In 1926 the writer warned against the dangers of cholecystectomy too early in the acute stage. That paper was prompted by several deaths which were attributable to too rapid intervention. It was my belief at that time as it is now, that in the majority of these cases it is far better that these patients be observed for 24 or 36 hours, or even longer to see whether or not the temperature, pulse rate and blood count will diminish, indicating a subsidence of the inflammatory process.

When the temperature remains elevated after 36 or 48 hours, the pulse rapid and the general appearance is not improving, we do a cholecystectomy or a cholecystostomy. However, we are not by any means averse to immediate operation upon admission if the patient's condition indicates prompt intervention.

The 'delayed' treatment. Few surgeons consider it wise that surgery in all cases of acute cholecystitis be postponed, delayed or deferred until a complete remission has taken place weeks or even months later, thus watchfully waiting for an acute process to become a distinctly chronic one. I believe it is a common experience among surgeons that many patients will refuse operation after the subsidence of their acute symptoms. This is unavoidable and in many instances little harm has been done by the delay of months or even years.

Bruggeman has pleaded for more conservative treatment of acute cholecystitis yet even he could not be classified as a surgeon demanding a complete subsidence in all cases prior to operation. He quotes the opinion of many surgeons throughout our country and abroad who agree with his conservative stand. He mentions the names of Lewis, Archibald, Muller, Deaver, Haggard and certain German

ful individualization is necessary if operative mortality is to be kept low. Although there are a few surgeons who insist upon immediate operation after the patient has been admitted to the hospital, the great majority prefer to intervene in from 1 day to 5 days, thus allowing sufficient time for beneficial pre-operative measures to be instituted.

We have divided these surgeons into three groups: (1) those who operate immediately upon admission of the patient to the hospital; (2) early, 1 day to 5 days; (3) delayed (weeks or even months). The mortality rate in the hands of the majority of surgeons is better in the so called "early" group of operators than in the so called "immediate" group.

In our series of cases, convalescence following gangrene and perforation has been smoother and more satisfactory than is usually stated by most authors.

The treatment of acute cholecystitis cannot be compared with the treatment of acute appendicitis. The exact cause of liver death and shock is unknown. Suggested causes are: intoxication due to the absorption of devitalized liver cells, disturbed liver metabolism and dysfunction, hidden infections.

Meticulous pre-operative study of the blood chemistry and the study of the bile if the ducts are drained will lower the mortality.

CONCLUSIONS

1. The majority of surgeons are obtaining better results by waiting from 1 to 5 days before operating upon patients suffering from acute cholecystitis. Time is thus given for the acute inflammatory process to subside and the patient offered the opportunity to be properly

prepared for the shock of a major surgical procedure.

2. The mortality rate will be higher in the hands of the majority of surgeons if "immediate" operation in all cases is advised.

3. More frequent and painstaking post-mortem examinations would no doubt throw light on the cause of "liver shock and deaths."

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1 A sudden release of biliary obstruction, rather than obstruction itself, is responsible for the fatal outcome in certain cases of biliary tract surgery

2 Liver changes already present in biliary tract disease are aggravated at times by operative measures which are supposed to relieve it, and thus there is released a toxic substance into the circulation which is presumed to be a water soluble foreign protein

3 When the function of the liver is stopped the kidney takes up the process of detoxication from which results damage to the convoluted tubules through which foreign proteins are excreted

4 The liver-kidney syndrome is a single pathological process of which the kidney pathology represents the second stage

Due to repeated failure at autopsy to find sufficient liver pathology to explain these repeated deaths, it has been suggested (5) that the fatal syndrome is not hepatic but extrahepatic with possibly an important cerebral factor so that careful postmortem examination of the brain should be insisted upon

Tourof has attempted to show that virulent infection may produce a chemical syndrome identical with so called "liver shock." He believes that often the infection is incapable of being detected, the patients being so ill that it is difficult for the examiner to determine the presence of any positive physical signs. He showed that often postmortem examination failed to reveal patients dying of so called "liver shock" but really succumbing to other complications

With the newer methods of determining liver function before operation some idea should be obtained as to whether or not this viscus can be held partially or completely responsible for the fatalities. The mortality following cholecystectomy due to liver dysfunction can thus no doubt be lowered by the more painstaking selection of cases

In jaundice, dye tests are of value in determining the activity of liver parenchyma and should be undertaken before operation in all such cases. Today, surgeons appreciate too infrequently the danger of the acute toxic liver incompetence which sometimes follows operative measures and which occasionally

results fatally. Whether the cause of these startling deaths is hidden infections, chemically altered liver cells, disturbed liver metabolism or liver dysfunction, meticulous preoperative data can and should be obtained

Pre operative management A satisfactory pre-operative program cannot be carried out with those patients who of necessity must undergo immediate operation. However in cases in which it is safe to allow the symptoms to subside and to plan interference some 4 to 6 days later it is of value

1 To know of upper respiratory infections and to treat them if they exist

2 To obtain thorough cleansing of the lower intestinal tract

3 To institute a minute laboratory investigation, with a complete blood count, blood chemistry studies, xanthoprotein, indican, and cholesterol esters determination. If the urea nitrogen is not within normal limits the liberal use of fluids is indicated. The blood sugar should be carefully noted. The sedimentation rate gives some index of liver damage, if elevated the liberal use of glucose insures glycogen store. The icteric index is a source of information as to blockage of the ducts, slight elevation of from 15 to 20 probably means a cholangitis or liver damage. Roentgen ray vision with dye is valueless if the patient is jaundiced and there is known to be liver damage, it is of doubtful value in the face of irritations of the gastro intestinal tract, such as peptic ulcer, acute appendicitis or malignancy

4 To give intravenous infusions of 1,000 cubic centimeters of 5 per cent glucose in saline twice daily, a diet high in carbohydrates and low in fats is recommended. Transfusions of blood are given to the jaundiced patient prior to, and immediately following operation, especially if there is profuse bleeding or a prolonged operating time. Liver function tests, though properly administered, often give but scant information, therefore, saturation with water and sugar should be given intravenously before and after any operative maneuver on the biliary tract

SUMMARY

No set time is feasible for surgical interference in all cases of acute cholecystitis. Care

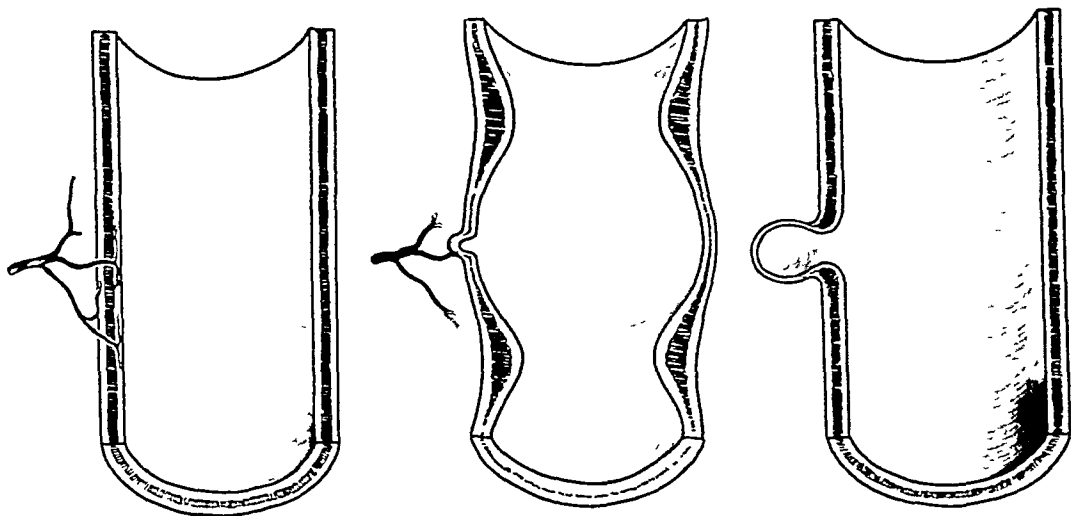


Fig 1 Various stages in the formation of a diverticulum; a, left, early stage, b, center, later stage, c, right, final stage,

showing how thinning of the muscular layer over the surface of the diverticulum takes place

gested that perhaps the dragging effect of the vessels supplying blood to the bowel produces diverticula

Our observations have led us to the belief that acquired diverticula originate, as both Edwards and Fraser have stated, in close proximity to the vascular supply of the intestine (Fig. 1). According to Butler, the pull of the vasa recti of the superior mesenteric artery as a result of sclerosis is probably an important factor in the formation of intra-mesenteric diverticula of the small intestine

C. H. Mayo once saw a diverticulum form during the course of an intestinal operation. It occurred on the mesenteric border of the sigmoid at a time when the proximal segment of bowel was in a state of contraction.

DIAGNOSIS AND TREATMENT

Duodenal diverticula. Of the diverticula of the intestine, about 18 per cent (Fig. 2) have as their site of origin the duodenum and they are present most often in individuals 50 years or more of age. Frequently, duodenal diver-

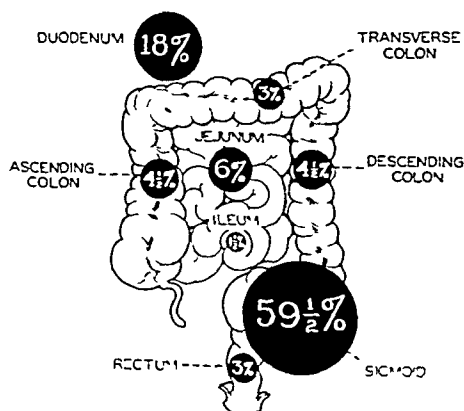


Fig 2 Incidence of diverticula in various portions of the intestine.

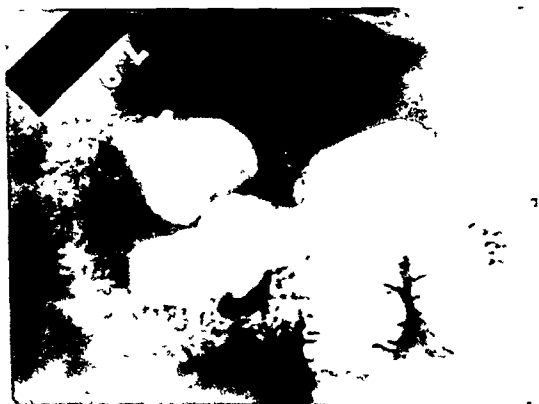


Fig 3 Duodenal diverticulum, showing characteristic extraluminal outpouching.

DIVERTICULA OF THE INTESTINE

CLAUDE F. DIXON, M.D. JOEL L. DEUTERMAN, M.D. and HARRY M. WEBER, M.D.
Rochester, Minnesota

DIVERTICULA of the intestine, when they are symptomless, may be considered as nothing more than anatomical curiosities. Such sacculations or pouches, however, may become the sites of an inflammatory process, or neoplastic changes may occur in them. The development of either of these conditions may produce symptoms requiring medical treatment or surgical intervention.

Some diverticula are congenital in origin (for example, Meckel's diverticulum), but the majority are thought to be acquired. It is quite logical therefore that inquiry should be made to learn the reason for their formation. Virchow, for example, described diverticula of the small intestine as herniations of the mucosa through the muscular layers of the intestinal wall. Edwards, in an extensive review of the literature on jejunal diverticula, together with a report of his own cases, emphasized the point that diverticula apparently invariably form in close proximity to the small vessels supplying the intestinal wall. He called attention to the fact that, usually, blood is supplied to the intestine by pairs of vessels. In confirmation of his theory as to the origin of diverticula, Edwards illustrated his paper with specimens and diagrams which showed diverticula arising in pairs corresponding to the points where the paired blood vessels entered the intestinal wall. He expressed the opinion that as the diverticula increase in size they encroach on one another and produce pressure on the mesial wall, with the end result that they become converted into a single diverticulum. Further evidence that diverticula originate at the point of entrance of blood vessels into the wall of the intestine is found in the fact that the majority of diverticula arise from the mesenteric side of the bowel.

Careful microscopic study of intestinal diverticula reveals for the most part a characteristic picture. It will be seen that the mucosa has herniated through the wall of the intestine and in some instances that the muscular layers cover a portion of the diverticulum. Near the base of the pouch the muscular structure is highly thickened, at the apex it is thinned out. Edwards also called attention to the almost valve like muscular apparatus at the mouth of the herniation.

THE MECHANISM BY WHICH INTESTINAL DIVERTICULA ARE FORMED

When contraction of the intestine occurs, it is obvious that the openings for the entrance of blood vessels become smaller in the contracting segment of the intestine while, in the relaxed portion, there is a tendency for such openings to become larger. If contractions occur when a relaxed segment of intestine is between two contracting portions, the pressure exerted on the relaxed segment where the vascular openings are larger may be sufficiently great to cause herniation. Most observers share this view regarding the causation or formation of diverticula. Some believe that the areas of decreased resistance in the wall of the bowel are produced by degeneration of the venous connective tissue, and that increased pressure within the intestine may cause the formation of diverticula through such areas. Sudsuki, particularly, has voiced this view. Fisher suggested that thinning of the circular muscular layer may occur and that, when this happens, an evagination of the mucous membrane may quite easily find its way through the longitudinal muscular layer to the serosal coat, forming a diverticulum. Fisher has also observed definite thickening of the peritoneal layer covering a diverticulum, thus is apparently an attempt to limit the process. Klebs has observed that some segments of bowel containing diverticula have an extremely short mesentery, and he sug-

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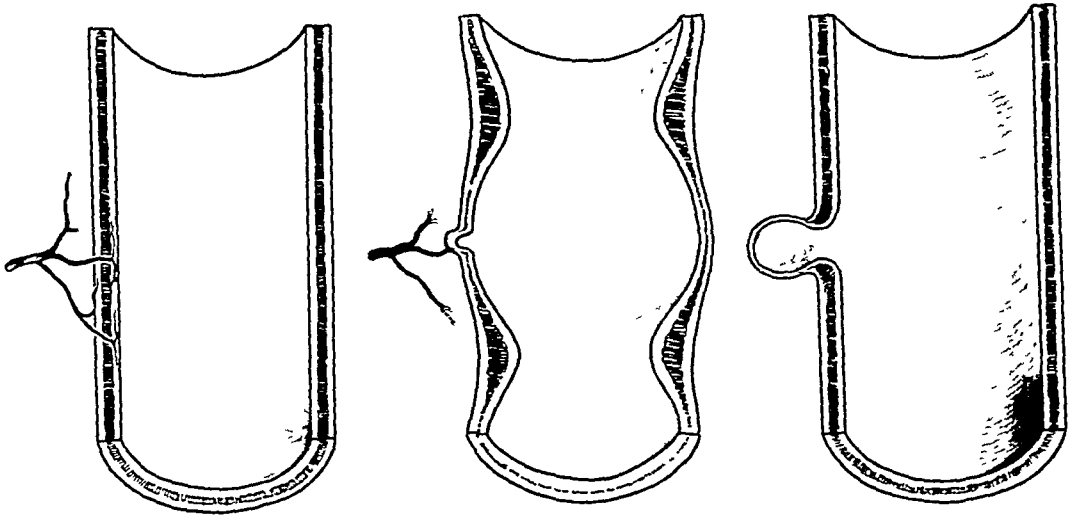


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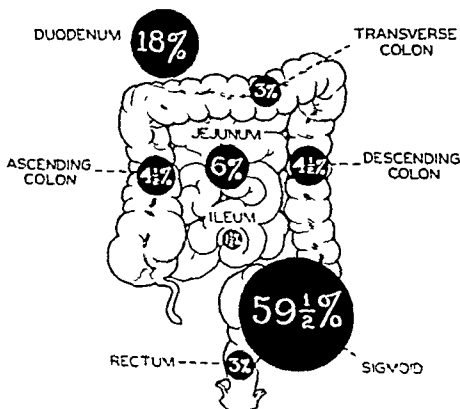


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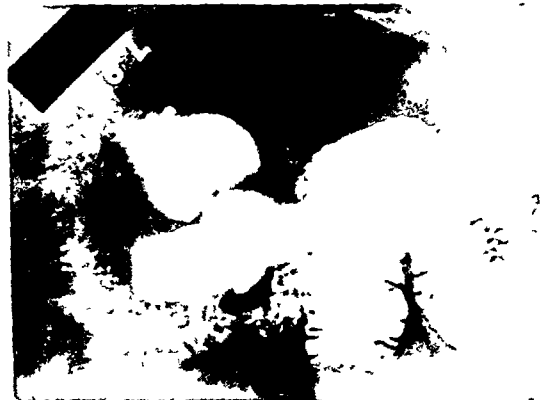


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Careful microscopic study of intestinal diverticula reveals for the most part a characteristic picture. It will be seen that the mucosa has herniated through the wall of the intestine and in some instances that the muscular layers cover a portion of the diverticulum. Near the base of the pouch the muscular structure is highly thickened, at the apex it is thinned out. Edwards also called attention to the almost valve like muscular apparatus at the mouth of the herniation.

THE MECHANISM BY WHICH INTESTINAL DIVERTICULA ARE FORMED

When contraction of the intestine occurs it is obvious that the openings for the entrance of blood vessels become smaller in the contracting segment of the intestine while, in the relaxed portion there is a tendency for such openings to become larger. If contractions occur when a relaxed segment of intestine is between two contracting portions, the pressure exerted on the relaxed segment where the vascular openings are larger may be sufficiently great to cause herniation. Most observers share this view regarding the causation or formation of diverticula. Some believe that the areas of decreased resistance in the wall of the bowel are produced by degeneration of the venous connective tissue, and that increased pressure within the intestine may cause the formation of diverticula through such areas. Sudeki, particularly, has voiced this view. Fisher suggested that thinning of the circular muscular layer may occur and that, when this happens, an evagination of the mucous membrane may quite easily find its way through the longitudinal muscular layer to the serosal coat, forming a diverticulum. Fisher has also observed definite thickening of the peritoneal layer covering a diverticulum, this is apparently an attempt to limit the process. Klebs has observed that some segments of bowel containing diverticula have an extremely short mesentery, and he sug-

From the Division of Surgery and the Sections on Surgery and on Pathology, The Mayo Clinic.
Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.



Fig 6a



Fig 6b.

Fig 6 a, Diverticulum (segment on superior surface) of ileum, b, showing marked ulceration in tip of diverticulum

usually symptomless. Occasionally, however, duodenal diverticula become large enough to produce symptoms of partial obstruction mechanically, in which event surgical intervention is indicated. The operative procedure of choice in such cases is dependent on certain factors in the individual case, the procedure most commonly undertaken being removal or inversion. It is quite obvious that the latter operation should be carried out only when the diverticulum is small.

The diagnosis of duodenal diverticula is not made clinically, and it is strictly roentgenologic when it is made before operation or

before necropsy. Since duodenal diverticula are often quite large, the characteristic extraluminal outpouching is usually recognized without difficulty as the opaque meal is followed along the course of the duodenum after it has passed through the pylorus. Figure 3 represents a typical instance. The patient was a man, aged 71 years, who for 20 years had complained occasionally of a sensation of fullness and bloating in the epigastric region after eating. His symptoms, plus the finding of a duodenal diverticulum, were not thought sufficient, however, to warrant surgical intervention.



Fig. 4 Multiple duodenal and jejunal diverticula



Fig. 5 Meckel's diverticulum of ileum

ticulum and duodenal ulcer are concomitant findings. Moynihan, however, said that these duodenal sacculations are not true diverticula but "pouchings" and that they were not related to true diverticula. So far as we know, it is impossible to say whether diverticula are more frequent in cases in which ulcer is pres-

ent, but if the diverticula are more prevalent in individuals who have ulcer, apparently the occurrence has not been explained. Possibly if the irritating cause is sufficient, contractions occur in another portion of duodenum synchronously, thereby producing herniation in the segment which is not undergoing spasm or contraction. The most frequent site of duodenal diverticula is near the ampulla of Vater. Even when large, such diverticula are



Fig. 5b Meckel's diverticulum of ileum

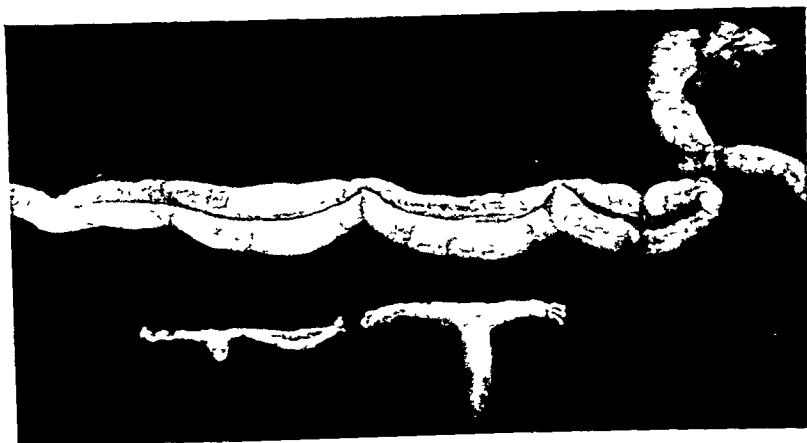


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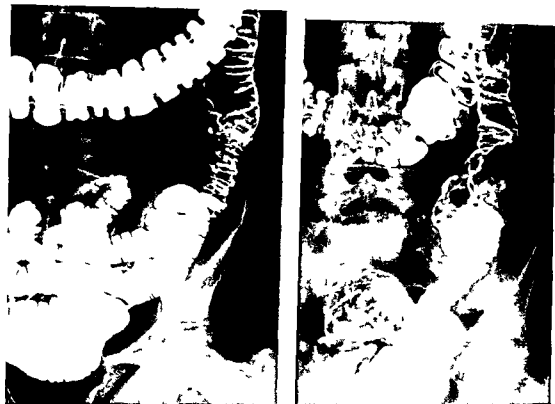


Fig 7 a left Diverticulitis of descending colon and b right carcinoma of descending colon, showing typical roent

Jejunal diverticula Hanseemann described a case in which, at necropsy, more than 400 diverticula were found in the jejunum. About 6 per cent of intestinal diverticula occur in this segment of the intestine, and as a rule, multiple diverticula will be found. Of 4,820 necropsies, 9 revealed jejunal diverticula. In many cases in which jejunal diverticula develop, the patients complain of gaseous rumbling in the upper left abdominal quadrant after meals; others experience intermittent cramping abdominal pain following the ingestion of food. In a few cases vomiting and diarrhea occur. The diagnosis of jejunal diverticulum is likewise chiefly a roentgenologic problem. Diverticula in this portion are also large and are generally recognized with ease as the opaque meal is observed to pass through these segments. As a rule the diverticulum does not evacuate the contrast substance readily, and the outpouching is readily

recognized even after the lumen in the immediate vicinity has contracted and propelled all but a very small residue of the opaque substance from the mucosal folds.

When surgical treatment is considered advisable, removal of the diverticulum or diverticula is carried out. If many herniations are present, then resection of the involved segment is the procedure of choice. Figure 4 shows many diverticula in the jejunum of a patient, aged 71 years, who did not give a history of any intestinal disorder save an occasional attack of diarrhea in the previous 10 years. Surgical intervention was thought to be inadvisable.

Diverticula of the ileum Only about 15 per cent of acquired intestinal diverticula occur in the ileum. Some cases of ileal diverticula have been reported in which the herniation arose from the mesenteric border. Most ileal diverticula, however, are congenital and

since Meckel's diverticulum is quite a common finding, the discussion will be limited to it. It is thought that Meckel's diverticulum is present in 2 per cent of all individuals.

The existence of Meckel's diverticulum may be suspected, but the diagnosis has seldom been made before operation. In several cases in which we have strongly suspected the presence of inflammation or disease in a Meckel's diverticulum, exploratory operation substantiated our preoperative impression. Persistent bleeding from the rectum in children is always suggestive of the presence of a Meckel's diverticulum. Also, attacks of cramp-like pain in the region of the umbilicus are often indicative of it. A few Meckel's diverticula have been found at operation in which the neck of the lumen was quite small and was the cause of complete or almost complete obstruction of the diverticulum, a condition somewhat analogous to that of the appendix in appendicitis. The presence of gastric mucosa in diverticula of the Meckel type is responsible for many of the ulcers that have been observed in these pouches, and it undoubtedly accounts for many of the symptoms. Gray and Kernohan have reported a case in which there was malignant degeneration of the gastric mucosa in a Meckel's diverticulum; microscopic study of the malignant process revealed a structure similar to that of gastric carcinoma. In 2 cases in which the heterotopic gastric mucosa in such diverticula had undergone ulceration, the patient observed that his pain ceased 2 or 3 hours after the ingestion of food. Pancreatic tissue has also been found in diverticula of the Meckel type.

Case was the first to demonstrate Meckel's diverticulum by the use of roentgen rays, many years elapsed before another instance was reported in the roentgenologic literature. Then others, among them Pfahler, Allemann, and Prévôt, reported other cases. Up to the present time Meckel's diverticula have been demonstrated roentgenologically on but 3 occasions at The Mayo Clinic. Since these diverticula vary so widely in their gross morphologic characteristics, a typical roentgenologic appearance is not to be described. The roentgenologic appearance may, how-

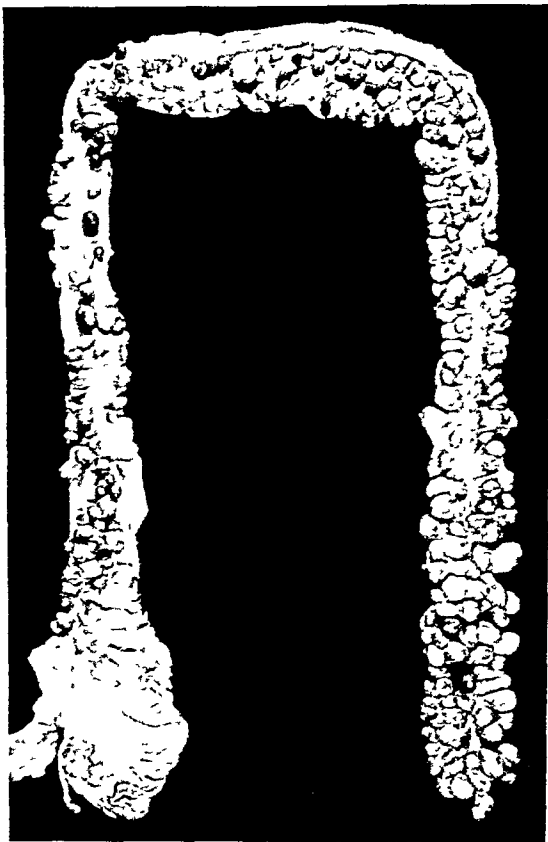


Fig. 8 Diverticulosis of colon.

ever, be expected to reflect the morphologic contour of the particular diverticulum. Figure 5 a and b illustrates this point in a satisfactory manner. The patient, a man 39 years of age, had had gaseous eructations for 10 years, and during the past year there had been knife-like pain and tarry stools. Marked ileitis was responsible for his symptoms and on this account 35 centimeters of ileum and colon were removed. However, a Meckel's diverticulum was also present and gave a typical roentgenographic manifestation.

In another case, a girl aged 5 years, blood had been passed by rectum on several occasions. In the 3 years prior to her examination at the clinic she had had attacks of diffuse, cramp-like abdominal pain. She also had severe asthma. On examination she appeared to be somewhat cachectic. There was marked secondary anemia. Abdominal exploration



Fig 7 a left Diverticulitis of descending colon and b right carcinoma of descending colon showing typical roentgenographic finding for both types of lesions

Jejunal diverticula Hanseemann described a case in which, at necropsy, more than 400 diverticula were found in the jejunum. About 6 per cent of intestinal diverticula occur in this segment of the intestine, and as a rule, multiple diverticula will be found. Of 4,820 necropsies, 9 revealed jejunal diverticula. In many cases in which jejunal diverticula develop, the patients complain of gaseous rumbling in the upper left abdominal quadrant after meals, others experience intermittent cramping abdominal pain following the ingestion of food. In a few cases vomiting and diarrhea occur. The diagnosis of jejunal diverticulum is likewise chiefly a roentgenologic problem. Diverticula in this portion are also large, and are generally recognized with ease as the opaque meal is observed to pass through these segments. As a rule the diverticulum does not evacuate the contrast substance rapidly, and the outpouching is readily

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Diverticula of the ileum Only about 1.5 per cent of acquired intestinal diverticula occur in the ileum. Some cases of ileal diverticula have been reported in which the herniation arose from the mesenteric border. Most ileal diverticula, however, are congenital, and

Carcinoma and diverticulitis may be co-existing conditions but there is no reason to believe that diverticulitis is a precursor of malignancy. The clinical differentiation between diverticulitis and malignancy of the colon is frequently difficult to make. The symptoms of an acute inflammatory process are, of course, in favor of a benign condition. The passage of a large amount of blood and mucus with the stool is one of the predominant symptoms of malignancy. Bagen and Dixon reviewed a large series of cases of diverticulitis and observed that noticeable bleeding by rectum was quite a rare symptom of that condition. A review of the differential roentgenologic diagnostic criteria has been made previously (5). It was pointed out that accurate differential diagnosis between these conditions is possible at the roentgenologic examination. Figure 7 a and b shows the typical roentgenographic manifestations of carcinoma (left) and diverticulitis (right). Both of these lesions are in the descending colon at the crest of the ilium.

The treatment of diverticulitis of the colon in its earlier stages is not a surgical problem. Even if there is marked deformity of the bowel due to diverticulitis, rest in bed, a non-residue type of diet, liberal doses of belladonna, and warm saline irrigations by rectum, frequently cause the process to subside. With care of the diet such individuals may continue throughout life with nothing more serious than an occasional attack. Figure 8 shows multiple diverticula throughout the colon of a man aged 89 who succumbed to a cerebral accident. Throughout life he gave no history of any intestinal disturbance. Figure 9 a and b shows roentgenograms of the colon before and after medical treatment of diverticulitis.

There are other cases in which the condition is intractable to all forms of medical management and operation obviously is indicated. It has been our plan to manage stricture formation surgically by establishment of a colonic stoma in an uninvolved portion of the

bowel proximal to the involved segment. The establishment of such an artificial anus frequently allows the inflammatory process to subside completely and closure of the colonic stoma can be carried out with good results subsequently. Judd was of the opinion that such colonic stomas should not be closed before a year had elapsed.

If it is obvious that more radical treatment for diverticulitis is required, the next surgical procedure to be considered is resection of the involved segment, and even this should sometimes be antedated by colostomy, particularly if there is abscess formation or perforation into an adjacent viscus such as the urinary bladder.

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Fig 9 Diverticulitis of sigmoid a left roentgenogram before medical treatment February 3 1934 b right after patient received medical treatment February 12 1934

disclosed a Meckel's diverticulum, 66 centimeters in length in the distal portion of which there was marked ulceration (Fig 6). The ileum and the diverticulum had a common mesentery, and removal without sacrifice of the ileum was therefore impossible. It was felt that the symptoms might abate if treatment similar to that for some peptic ulcers were employed, and for that reason an anastomosis was made between the ileum and the diverticulum. Unfortunately, however the patient succumbed to bronchopneumonia a few days following operation.

It must be admitted that in the past, roentgenologic examination seemed to have little to offer in the diagnosis of this condition. It may be predicted, however that the roentgenologic diagnosis of Meckel's diverticula will become more and more satisfactory as roentgenologic experience with them accumulates. Such Meckel's diverticula as are small and communicate with the lumen of the bowel by a very wide neck will, however, be recognized roentgenologically only with the greatest difficulty, and in a certain number of the

cases will inevitably escape roentgenologic detection.

Diverticula of the colon By far the majority of diverticula (about 60 per cent) occur in the sigmoid, some have stated that as high as 80 per cent of colonic diverticula occur in the lower part of the descending colon and sigmoid. The condition in which one or more diverticula have been formed is known as "diverticulosis."

The term "diverticulitis" is applied to that state in which one or more of the diverticula have become inflamed. It has been estimated that in about a fifth of people with diverticulosis, diverticulitis develops. The complications and sequelae of diverticulitis are stricture formation, perforation with abscess formation, or perforation into or onto another viscus, peritonitis and fistula. The symptoms of acute diverticulitis are similar to those of acute appendicitis except, of course that in the former the symptoms are confined to the left lower quadrant of the abdomen. About 33 per cent of patients with diverticulitis have a palpable mass in that region.

effect, however, is a great slowing of the heart rate. When the abdominal muscles relax, the intra-abdominal pressure falls, and the excessive quantity of blood which has been forced into the chest flows back out of it. Thus over-dilatation of the heart is prevented. If vomiting occurs after the vagi have been cut, it is accompanied by a great rise of blood pressure.

Is the intra-abdominal circulation impeded when the intra-abdominal pressure is greatly increased by ascites, by the pregnant uterus, or by tumors? The abdominal veins have walls of paper thinness which are easily compressed by the slightest pressure. It would seem that they would be blocked when the intra-abdominal pressure is elevated, but every day experience shows that they are not, and that the blood flow through the abdominal viscera is not stopped by even an enormous increase in the intra-abdominal pressure. The question is answered by the results of the following experiment:

Arrangements are made to record the systolic blood pressure, the intra-abdominal pressure, and the pressure in the vena cava. The intra-abdominal pressure is then elevated by injecting normal salt solution into the peritoneal cavity. As the intra-abdominal pressure increases, the pressure in the vena cava increases, and the two are always equal. When the intra-abdominal pressure equals the systolic blood pressure, all flow through the abdominal organs ceases, and they are white and bloodless.

From this experiment we conclude (1) that the heart forces enough blood through the capillaries to maintain an intravenous pressure equal to the intra-abdominal pressure; (2) that the intra-abdominal circulation cannot be stopped by any increase in intra-abdominal pressure lower than the diastolic blood pressure.

The second conclusion requires comment. When the pressure upon a capillary equals the diastolic blood pressure, the flow of blood through it occurs only in systole when the arterial pressure rises above the diastolic pressure. The flow, therefore, consists of a series of brief spurts. As we shall show later, the resulting volume of blood flow is insufficient to maintain the normal activities of the tissues.

It has been shown experimentally that when salt solution is injected into the peritoneal cavity in sufficient quantity to increase the intra-abdominal pressure to equality with the diastolic blood pressure, the absorption of the salt solution is very slow (10).

In the experiment just described, sudden removal of the fluid caused no noteworthy change in the blood pressure. The collapse of the patients who, while in the sitting position, have had large amounts of ascitic fluid removed, is to be attributed for the most part to the inability of the overstretched abdominal walls to compress the great capillary and venous reservoir of the abdomen sufficiently to provide an adequate supply of blood to the heart. Of course, a vasomotor relaxation within the abdominal viscera would hasten the onset of this difficulty, which is not likely to occur if the patient is kept in the recumbent or head-down position.

The venous return from the lower extremities is not prevented by increased intra-abdominal pressure as long as the valves in their veins are intact. If the femoral vein be tied and cut just below Poupart's ligament, it will be found that the venous pressure in its distal portion, as measured with a mercury manometer, is equal to the systolic blood pressure. It may be increased until it is several times greater than this by compression of the leg. The valves in the leg veins give them the power of a force pump, so that contraction of the leg muscles around the veins raises the intravenous pressure to any height necessary to force the blood from the femoral into the iliac veins.

DISTURBANCES OF CIRCULATION LIMITED TO SINGLE ABDOMINAL ORGANS

Distention and venous obstruction are the common causes of circulatory disturbance in the hollow, distensible abdominal organs. Venous obstruction affects chiefly those organs having a mesentery.

Effects of distention. These can be produced and studied most conveniently in the wall of the intestine. Facts established by this study apply in general to the circulation of any hollow, distensible viscus. The set-up for this study is shown diagrammatically in Figure 1.

DISTURBANCES OF THE BLOOD AND LYMPH CIRCULATION OF THE ABDOMEN

W D GATCH M D F A C S, Indianapolis Indiana

THIS paper covers only those disturbances of the abdominal circulation which are peculiar to it. Disturbances due to embolism, thrombosis, arterial disease, and cardiac failure are not within its scope. It deals chiefly with acute derangements of circulation such as may occur in fairly healthy patients who require operation. These may affect the entire abdominal circulation or they may be limited to the circulation of a single organ.

DISTURBANCES OF THE ABDOMINAL CIRCULATION AS A WHOLE

The abdominal vessels have two important functions beside supplying blood to the abdominal organs. They serve as a reservoir to regulate the flow of blood in the lesser circulation. Some of them, in the liver and spleen, constitute a wonderfully efficient apparatus to remove bacteria and other particulate matter from the blood.

Disturbances of the flow of blood from abdomen to thorax. The great capacity of the abdominal vessels is obviously of advantage at times to the entire circulation, because it permits the temporary storage of blood in the abdominal organs when, for any reason, the supply of blood to the heart is greater than it can pump. The quantity of blood in the abdomen varies between wide limits. In man after fasting it probably does not exceed 25 per cent of the total blood volume. It is possible to impound

in the abdomen of a dog nearly all the blood in its body.¹

The absence of valves in the abdominal veins permits a rapid backflow into them of blood accumulated in the thorax. In the course of general anesthesia, the head down position or vigorous struggling may prevent this unloading of the thoracic veins, and thereby imperil life. This danger is not great unless the air way is obstructed. Then a high negative pressure in the chest accelerates the flow of blood from abdomen to thorax. This over dilates the heart when it is suffering from anoxemia. Experiments show that this evil combination may damage a normal heart beyond recovery in a time as short as 2 minutes (7).

Failure of a normal quantity of blood to leave the abdomen is present when the abdominal muscles are paralyzed and the patient put in the erect posture. Thus a deeply anesthetized animal dies if kept in the head up position because of the accumulation of blood in the abdomen. Patients with paralyzed abdominal muscles cannot remain upright for any considerable time. It would seem that compression of the abdominal viscera by the muscles which enclose them is essential to the maintenance of the circulation under the ordinary conditions of life (6).

Ejection of the stomach contents by vomiting is accomplished by powerful compression of the stomach by simultaneous contractions of all the muscles which enclose the abdomen. This expels from the abdomen not only the contents of the stomach but a large quantity of blood as well, the blood being forced through the inferior vena cava into the right chambers of the heart. Nature has evolved a remarkable adaptation to protect the heart in this event. During vomiting there is a vagal inhibition of the heart. This may cause the blood pressure to fall to zero because of a complete cessation of heart action. The usual

Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1927.

Two determinations of the quantity of blood in the abdomen of the fasting dog were made. The total blood volume was determined by the dye method. The dog was then killed instantly with cyanide and its aorta, axillary veins, vena cava ascending and common iliac vessels were clamped. All blood was then expelled from the abdominal viscera by forcing first physiological salt solution and then air into the aorta. The escaping fluid was collected from the vena cava. Sections of the viscera after this showed them to be bloodless. In one experiment 10 per cent and in the other 25 per cent of the total blood volume was obtained. In the human the quantity of blood in the abdomen (after fasting) is probably somewhat greater, possibly 25 per cent. For the effect of food on the blood flow of the digestive organs see Mann (9).

found that various sugars pass through the living bowel at fixed rates which are different for each sugar. In about 6 hours they all begin to pass through more rapidly and at the same rate. Six hours is therefore a fairly accurate estimate of the survival time of the detached bowel.

Both types of experiment show that the bowel can endure a remarkably long period of anemia. Under clinical conditions the intestine may not be injured beyond recovery by several days of distention. This is because the distention is usually intermittent. It is probable, however, that distention may injure the intestinal mucosa enough to deprive it of power to keep toxic substances, always present in the bowel lumen, out of the blood. Even in this event, the body is protected from harmful absorption by way of the mesenteric veins if the bowel is distended by a force equal to the diastolic blood pressure. Patients suffering from advanced bowel obstruction may have a very low diastolic blood pressure, which can easily be equalled by the intra-intestinal pressure.¹ If the latter be suddenly reduced, the circulation through the bowel will be restored and the absorption of toxic material will occur.

A probable explanation of death following shortly after the release of a bowel obstruction is that the operative trauma causes an overwhelming absorption of toxic material both by the mesenteric and by the transperitoneal route. Weatherby and Chen have shown that toxic material can pass through the entire wall of the partially devitalized bowel. It has been demonstrated that the inflammatory exudate thrown out by the peritoneum about the damaged bowel hinders the absorption of toxic material which has passed through the bowel wall. It is easily conceivable that the removal of this exudate over long reaches of bowel may lead to the absorption of a fatal dose of toxins (10). Toxins absorbed by way of the mesentery pass through the liver, which has a well known detoxifying action; those absorbed by the transperitoneal route pass directly into the systemic circulation.

It is certain that by gradual deflation of the

¹Since the function of the bowel is carried on in a fairly normal manner as long as the intra-intestinal pressure does not exceed the diastolic blood pressure, it is probable that the bowel mucosa will not be injured enough to permit the passage of toxins unless the intra-intestinal pressure equals the diastolic blood pressure.

bowel and relief of dehydration before operation, the death rate from advanced bowel obstruction can be greatly reduced.

Effects of distention on hollow viscera other than the bowel. The effects of distention on the appendix and cystic ovary are much the same as on the intestine. The effects on the gall bladder are peculiar and call for special comment.

Distention of the gall bladder. If the cystic duct of an experimental animal be tied, the gall bladder will be found, after a few hours, to be contracted. If the common duct be tied and the cystic duct left open, then the gall bladder becomes greatly distended (13, 16). In the former case the gall bladder remains contracted because of the rapid absorption of water from its contents. In the latter case it becomes distended because its power of abstracting water from its contents is not sufficient to cope with the constant arrival of more fluid by way of the cystic duct.

When this condition exists in the human subject, due to obstruction of the common bile duct by cancer, the gall bladder distends to five or six times its normal size, but rarely or never becomes gangrenous. The pressure within it, probably from 250 to 300 millimeters of water (14), is too low to cause a dangerous impairment of circulation. The gall bladders dealt with by the surgeon are usually without function, which means that they have little or no power to absorb water from their contents. A gall bladder in this condition may become distended to a great size. In one observed by the writer the distention was intermittent and apparently due to the presence of a ball valve stone in the cystic duct. Here the gradual stretching of the gall bladder permitted the maintenance of the circulation. Massive gangrene of the gall bladder and appendix cannot be explained by distention, but is probably always due to venous obstruction.

Effects of venous obstruction. In the intestinal preparation we have described, if a manometer be tied into the vein draining the closed piece of bowel, the venous pressure, as measured by the manometer, will be seen to rise until it equals the systolic blood pressure. This is proof that the systolic blood pressure in the presence of venous obstruction is trans-

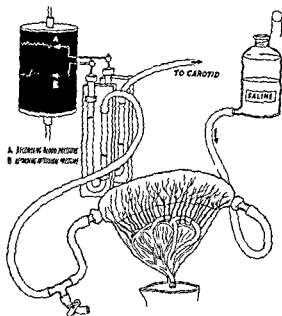


Fig. 1 Diagram showing set up used in study

By means of this preparation and modifications of it we can show

1 That the venous outflow from a distended bowel decreases as the intra intestinal pressure increases, and ceases when the intestinal pressure equals the systolic blood pressure¹

2 That distention of the bowel causes no venous congestion thereof This can be demonstrated easily by measuring the venous pressure in a branch of the outflowing vein when the latter is not obstructed I mention this to disprove the idea, which appears in the literature, that distention of the bowel causes a venous congestion of it

3 That the bowel is in no way injured by an intra intestinal pressure short of that necessary to rupture it, provided the pressure is present for a short time only After deflation the bowel can be made to contract normally, and, on microscopic study of its wall, no damage thereto can be observed

4 That the function of the bowel as shown by its power of absorption is carried on in a

1. A rest of the blood flow by distention, which is attributed to the negative pressure in the lumen of the intestine. This is not true as the pressure is shown by a manometer in the dilated bowel when its artery is filled with blood. The artery of all the bowels is a part of the arterial system, and it is not possible to distend the organ, they supply. The rest of blood is due to compression of the capillaries.

fairly normal manner in the presence of intra intestinal pressure lower than the diastolic blood pressure, but that all absorption except by the transperitoneal route ceases when the pressure is higher than this²

5 That distention of the bowel causes no edema of its wall, and diminishes or abolishes secretion by its mucosa. The bowel, when tightly distended, becomes covered by drops of fluid, it is true, but these are composed of plasma squeezed from the tissues

6 That tightly distended loops of bowel kept for a number of hours in the abdomen gradually increase in diameter and may remain viable provided the pressure within them does not increase as fast as their walls are stretched. The enlargement of the bowel under these conditions diminishes the pressure on the capillaries of its wall and permits a resumption of the blood flow

The effects of anemia on the bowel wall can be studied also by experiments on pieces of fresh, detached rabbit intestine. By this means we can determine how long the totally anemic bowel can survive. This determination was made at my request first by Dr. J. H. Weatherby and later by Dr. K. K. Chen (10). The bowel was assumed to be alive as long as its power of selective absorption was not completely lost. The normal bowel will not absorb histamine, proteoses, and peptones. It absorbs sugars at a definite rate.

The experiment was performed by immersing closed pieces of fresh intestine, containing one or more of these substances in Ringer's solution. The latter was tested at frequent intervals for the material in the bowel.

Chen found that pure peptone will not diffuse through the bowel wall in 24 hours. He found that histamine begins to diffuse in about an hour, its passage being slow until after the sixth hour when it rather suddenly begins to pass through at a greatly increased rate. He

1. A number of dogs we tested the effect of distention upon the rate of passage of a piece of bowel several feet in length we applied a ligature to the middle. We inflated it with a piece of bowel it excluded but not the other. In an experiment I did we obtained more than a man's quantity of fluid in the distended piece of bowel. We then removed the ligature and the fluid was absorbed. We always obtained a small but measurable amount of fluid from the distended piece of bowel. The pressure was maintained from half the diastolic blood pressure to the systolic pressure. This was the reason for the distention of the bowel. It is well known that the passage of fluid into the bowel is determined by the pressure of the blood in the arteries of the bowel.

found that various sugars pass through the living bowel at fixed rates which are different for each sugar. In about 6 hours they all begin to pass through more rapidly and at the same rate. Six hours is therefore a fairly accurate estimate of the survival time of the detached bowel.

Both types of experiment show that the bowel can endure a remarkably long period of anemia. Under clinical conditions the intestine may not be injured beyond recovery by several days of distention. This is because the distention is usually intermittent. It is probable, however, that distention may injure the intestinal mucosa enough to deprive it of power to keep toxic substances, always present in the bowel lumen, out of the blood. Even in this event, the body is protected from harmful absorption by way of the mesenteric veins if the bowel is distended by a force equal to the diastolic blood pressure. Patients suffering from advanced bowel obstruction may have a very low diastolic blood pressure, which can easily be equalled by the intra-intestinal pressure.¹ If the latter be suddenly reduced, the circulation through the bowel will be restored and the absorption of toxic material will occur.

A probable explanation of death following shortly after the release of a bowel obstruction is that the operative trauma causes an overwhelming absorption of toxic material both by the mesenteric and by the transperitoneal route. Weatherby and Chen have shown that toxic material can pass through the entire wall of the partially devitalized bowel. It has been demonstrated that the inflammatory exudate thrown out by the peritoneum about the damaged bowel hinders the absorption of toxic material which has passed through the bowel wall. It is easily conceivable that the removal of this exudate over long reaches of bowel may lead to the absorption of a fatal dose of toxins (10). Toxins absorbed by way of the mesentery pass through the liver, which has a well known detoxifying action; those absorbed by the transperitoneal route pass directly into the systemic circulation.

It is certain that by gradual deflation of the

¹Since the function of the bowel is carried on in a fairly normal manner as long as the intra-intestinal pressure does not exceed the diastolic blood pressure, it is probable that the bowel mucosa will not be injured enough to permit the passage of toxins unless the intra-intestinal pressure equals the diastolic blood pressure.

bowel and relief of dehydration before operation, the death rate from advanced bowel obstruction can be greatly reduced.

Effects of distention on hollow viscera other than the bowel. The effects of distention on the appendix and cystic ovary are much the same as on the intestine. The effects on the gall bladder are peculiar and call for special comment.

Distention of the gall bladder. If the cystic duct of an experimental animal be tied, the gall bladder will be found, after a few hours, to be contracted. If the common duct be tied and the cystic duct left open, then the gall bladder becomes greatly distended (13, 16). In the former case the gall bladder remains contracted because of the rapid absorption of water from its contents. In the latter case it becomes distended because its power of abstracting water from its contents is not sufficient to cope with the constant arrival of more fluid by way of the cystic duct.

When this condition exists in the human subject, due to obstruction of the common bile duct by cancer, the gall bladder distends to five or six times its normal size, but rarely or never becomes gangrenous. The pressure within it, probably from 250 to 300 millimeters of water (14), is too low to cause a dangerous impairment of circulation. The gall bladders dealt with by the surgeon are usually without function, which means that they have little or no power to absorb water from their contents. A gall bladder in this condition may become distended to a great size. In one observed by the writer the distention was intermittent and apparently due to the presence of a ball valve stone in the cystic duct. Here the gradual stretching of the gall bladder permitted the maintenance of the circulation. Massive gangrene of the gall bladder and appendix cannot be explained by distention, but is probably always due to venous obstruction.

Effects of venous obstruction. In the intestinal preparation we have described, if a manometer be tied into the vein draining the closed piece of bowel, the venous pressure, as measured by the manometer, will be seen to rise until it equals the systolic blood pressure. This is proof that the systolic blood pressure in the presence of venous obstruction is trans-

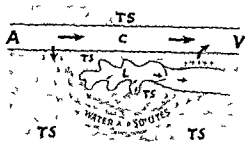


Fig. 2. Diagram to illustrate the interchange of materials through the capillary wall. *C*, blood capillary; *L*, lymph capillary; *TS*, tissue spaces around both.

mitted through the capillaries into the vein. Under these conditions the bowel soon becomes thick and sodden with extravasated blood. Its mucosa becomes detached and all its tissues disorganized. This is because of rupture of the capillaries by a pressure they are not able to withstand. This mechanism is the most common cause of disturbances of the circulation of individual abdominal organs. It is present when a loop of bowel passes into the neck of a hernial sac or beneath a peritoneal band. It is present in volvulus of the bowel and in rotation of an ovarian cyst on its pedicle. In all these cases the thin wall of the vein is compressed, whereas the artery is not, so that it continues to pour blood into the tissues. Early gangrene is the result. Distention of a hollow viscus may protect its capillaries from the disastrous effects of venous obstruction.

EXPLANATION OF OBSERVATIONS

The explanation of the foregoing observations is to be sought in the laws which govern the capillary blood flow and the interchange of materials through the capillary wall.

The discovery by Starling (17) that the blood proteins produce a measurable osmotic pressure, permitted him to formulate his theory, now generally accepted, on the interchange of water and other materials between the blood and lymph. This has been of great help to clinical medicine—for example in the explanation and treatment of edema and surgical shock. Krogh expresses the present day opinion of physiologists when he points

out that the interchanges under consideration can be explained as due to an interplay of filtration and osmotic pressures, without invoking the aid of a mysterious, vital secretory action by the thin endothelial cells of the blood and lymph capillaries. This matter can be most easily explained by means of the diagram, Figure 2, which shows the following: *C* is a blood capillary, *L* a lymph capillary, *TS* tissue spaces around both. The wall of *C* is easily permeable to water and soluble material and almost impermeable to proteins. The wall of *L* is permeable not only to water and soluble material but to proteins and particulate matter as well. The blood pressure in *C* tends to force water into *TS*. The osmotic pull of the proteins in *C* opposes this filtration and tends to draw water from *TS* into *C*. In the arterial end of *C* the filtration pressure is greater than the osmotic pull, and water passes into *TS*. At the venous end of *C*, the osmotic pull exceeds the filtration pressure, and water passes into *C*. Soluble materials in *TS* and *C* diffuse so readily through the wall of *C* that they can exert at most only a temporary effect on the passage of water.

The passage of water back and forth through the wall of *C* is influenced by osmotic and mechanical pressures in *TS*. The osmotic pressure in *TS* favors the outward passage of water from *C* and hinders its inward passage, while the mechanical pressure in *TS* has the contrary effects.

While these pressures in *TS* under normal conditions are relatively unimportant, they are all important in the derangements of circulation we have been describing. Thus, when the bowel is inflated, the stretching of its wall raises the mechanical pressure in *TS*. It is evident that as this increases, the blood flowing through *C* will decrease and cease to flow continuously when *TS* equals the diastolic blood pressure. It is evident also that elevation of the pressure in *TS* will diminish or abolish filtration of water from *C*, and that it will not injure *C* unless it is great enough to tear the tissues asunder. The effects of elevating the pressure in *TS* upon the function of the tissues are exactly what would be expected. When the pressure in *C* is elevated by venous obstruction to the level of the systolic blood

pressure, it is evident that the rupture of *C* is inevitable. Since the intracapillary pressure rises as the venous pressure rises, there can be no absorption of water by the capillary in the presence of a certain low degree of venous obstruction.

DISTURBANCES OF THE ABDOMINAL LYMPHATIC CIRCULATION

It is clear that disturbances of the blood flow, which we have been discussing, are always accompanied by disturbances of lymph flow. Thus, elevation of the intra-intestinal pressure beyond a certain height will abolish the flow of lymph in the abdominal wall; a slight rise in intravenous pressure will increase the flow of lymph, while complete venous obstruction will abolish it.

The clinical literature on the abdominal lymphatics has dealt almost entirely with means of preventing the absorption of toxic material by them. In the early days of abdominal surgery, there was a great fear of the escape of bacteria and toxins from the peritoneal cavity by way of lymph vessels. This was due to the idea that the peritoneal cavity is an immense lymph space, draining freely through openings in the peritoneum of the diaphragm into thoracic lymph vessels. The Fowler position was supposed to retard this drainage. Histological study has shown, however, that no openings through the peritoneum exist, that its mesothelium is everywhere continuous, and that it is not a part of the lymphatic system (2, 12). Furthermore, studies on absorption from the peritoneal cavity have shown that it is chiefly by way of the blood vessels (3). These absorb water and solutes, and apparently may take up bacteria and other small solid particles. The lymphatics take up only proteins and solid particles. Many solid particles, however, do not leave the peritoneal cavity, but are fixed *in situ* by exudate (10). Moreover, both clinical and experimental observations show that absorption from the inflamed peritoneum is very slow. "This fact," says Hertzler, "is self-evident, for the result of reaction to irritation is exudation, not absorption." David and Sparks have shown that the protective action of peritoneal exudates is very efficient. Every

day clinical experience supports this conclusion.

It seems to me that the evidence indicates that there are two more or less separate systems of lymphatics in the abdomen. The first of these supplies the gastro-intestinal canal and its accessory glands. It drains directly into the thoracic duct. The lymph in the thoracic duct comes chiefly from these lymphatics. It carries a heavy load of blood proteins. It is well known that the capillaries of the liver and intestine are more permeable to the blood proteins than are the capillaries in other parts of the body. It appears that the thoracic duct system is a special mechanism, the chief functions of which are the transportation of fat absorbed by the intestines and the rapid return of blood proteins to the blood (18).

The second system supplies the parietal peritoneum, it drains chiefly into the mediastinal lymph glands, and seems to have only circuitous communications with the thoracic duct.

Drainage of the thoracic duct, therefore, as a treatment for peritonitis is both inefficient and harmful. It removes little or no toxic material from the peritoneal cavity and depletes the blood of its proteins.

CONCLUSIONS

The abdominal veins act as a reservoir to regulate the supply of blood to the heart. Disturbances of this function may endanger life. The pressure in the intra-abdominal veins is always equal to the intra-abdominal pressure.

The circulation of the hollow, distensible organs of the abdomen may be impaired either by distention or by venous obstruction. The effects of distention are caused by an increase of pericapillary pressure; those of venous obstruction by an increase of intracapillary pressure. Arrest of the blood capillary circulation causes arrest of the lymph circulation, also.

Efforts so far made to treat peritonitis by preventing absorption from the peritoneum by way of lymph vessels have been based on erroneous ideas of the anatomy and the function of the abdominal lymphatics. The

prophylactic treatment of peritonitis by the production of aseptic inflammation of the peritoneum is well founded

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TUBERCULOSIS OF THE KIDNEY

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THERE is nothing new to present upon renal tuberculosis. Methods of diagnosis and treatment have not changed in 20 years. The condition is surgical and nephrectomy is in order when the diagnosis is made. So I thought when the invitation to give this address arrived. After studying my own results with 181 patients cared for on this policy and after reviewing the literature to date, I still think so. This point of view, however, has been undermined by the suspicion, arising from recent experimental and pathological studies, that the disease is bilateral at onset, that this early bilateral tuberculosis may spontaneously heal on one or both sides and therefore that nephrectomy is not always in order as soon as the diagnosis is definite. In the opinion of those who hold this view the chance of cure by medical means should be given and, if a medical cure fails, nephrectomy should be postponed at least until the lesion is advanced far enough to have established some immunity.

The conflict of these ideas is detrimental to the victims of renal tuberculosis. Some patients will miss a chance of cure because the tuberculous kidney was not removed promptly, as the lesion will have spread to the bladder, to the opposite kidney, or to the genital tract. On the other hand, according to the opposing viewpoint, some patients who might have got well without it will suffer nephrectomy and among these will be some who, by this unnecessary and hurried operation, will have had tubercle bacilli let loose into their blood stream to form new lesions elsewhere or to stir old lesions into activity.

These differences of opinion are not irreconcilable. Nevertheless their variance is so apparent and, if not reconciled, so dangerous, that it is important to establish whatever accord there is in them. The truth in each may be brought out by a discussion of certain

practical points of diagnosis and treatment.

The diagnosis of tuberculosis of the kidney is established by finding pus and tubercle bacilli in the urine from that kidney. No other findings are needed. Pus without organisms of any kind arouses the suspicion of tuberculosis; tubercle bacilli alone have a meaning to be guessed at, but pus and organisms mean active tuberculosis.¹ Each examination leading to this conclusion, however, must have been precise and the findings true. Of this there must be no question. All possible sources of error must have been perceived and removed. The preliminary steps of examination which form the basis for special urological study are the history, the physical examination (particularly of the chest in all patients and, in males, of the external genitalia, the prostate, and seminal vesicles, in females, of the reproductive tract), the examination of the urine, tests of renal function, and x-ray exploration of the chest and urinary tract. These non-instrumental methods of examination should be complete in every detail before cystoscopic study is undertaken. On their completion urogenital tuberculosis usually is known to be present even though its extent and form are not known.

The use of the cystoscope and ureteral catheters now fulfills the need of a complete diagnosis. In no field of medicine can diagnosis be more exact nor the technical steps of achieving that diagnosis more precise. There would be no need for this if renal tuberculosis were a medical problem. Cystoscopy and ureteral catheterization, however, localize the lesions and make known their true extent and activity. By reason of the precision in accomplishing this, surgery of renal tuberculosis has been successful. Although you are not interested in the details of this examination, you should know that it results in wrong diagnoses and serious complications when carelessly per-

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¹It has been my custom to check this finding by a second examination and when pus and tubercle bacilli have been found twice in the urine from a kidney I have never hesitated to advise nephrectomy.

TABLE I—CLASSIFICATION OF RENAL TUBERCULOSIS

	epi/srectomy
Division I Unilateral	
1 Localized (no involvement of the bladder)	40
2 With involvement of the bladder	
a Mild	13
b Extensive	51
c With constriction of the ureter of the opposite kidney producing renal insufficiency	17
Total	81
3 With involvement of the genital tract	
a With involvement of epididymides	8
b With involvement of the prostate and seminal vesicles	2
c With involvement of epididymides, prostate, and seminal vesicles	13
Total	23
4 With extra urogenital tuberculosis	
a With involvement of lungs	17
b With involvement of bones	4
c With involvement of lungs and bones	4
Total	25
Total	169
Division II Bilateral	12
Total	181

formed. The study of the urine collected by catheter from each kidney leads the list in importance. When a ureter cannot be catheterized or a kidney forms no urine for study, the other tests then carry more weight. Among such tests, those of relative function are of value mainly as proof of the sufficiency of the opposite kidney to carry on after the diseased one is removed. Excretory urograms show both functional ability and structural changes but excretory urograms must be interpreted with caution and rarely should be accepted alone as enough for diagnosis. Retrograde pyelography of a kidney—a study of the urine from which has proved that kidney to be tuberculous, seems to me to be wholly unnecessary and not without danger. It can add nothing of value to diagnosis and because of the ease of pyelovenous backflow, it can flood the blood stream with tubercle bacilli. The urologist who requires a pyelogram showing the defects of filling caused by tuberculosis in order to complete his diagnosis of tuberculosis is not precise. The cystoscopic examination of a patient suspected of having tuberculosis of the kidney should not be carried through in the usual routine way, which usually consists of first, the collection of speci-

mens, (a) for microscopic study, (b) for culture and (c) for phthalein test of renal function—all of which are put aside and sent to the laboratory for study by a technician, and then pyelography (in the prone and upright positions). By this routine, the diagnosis is made from the pyelogram and then confirmed in a day or so by a report from the laboratory. It is my belief that a microscope and centrifuge available for use at the time of the cystoscopic examination are as necessary as the cystoscope and ureteral catheter for the precise diagnosis of renal tuberculosis. When pus and tubercle bacilli are found, pyelography is not needed and, because it is dangerous, should be condemned. Retrograde pyelography, however, is often valuable in determining the condition of an opposite non-tuberculous kidney which may be hydronephrotic, may contain stones or tumors or may be otherwise abnormal. It should be used only when the intravenous urograms are unsatisfactory and then only after all the known precautions against ureteropelvic reflux and soiling of the contents of the renal pelvis by catheter have been used. All of these precautions (a bladder well washed out and safeguarded against overdistention, each ureteral catheter filled with sterile water, the outside end securely plugged and the inside end surface lubricated for from 3 to 4 centimeters with sterile olive oil) should be used for every patient suspected by preliminary study of having tuberculosis. The foregoing points of diagnosis are clear and definite. Uncertainty arises when tubercle bacilli cannot be found or when there is a tubercle bacilluria without pus.

A sterile pyuria (pus in the urine without organisms detected by the ordinary methods of staining or cultivation) occurs not only in renal tuberculosis but also in the terminal stages of some pyogenic infections and in a disease rarely seen in this country but frequently reported abroad as an acute oblique pyuria. As a rule, these non-tuberculous forms of sterile pyuria can be recognized the first form by the past history of cystitis and pyelonephritis and the fact that a few irrigations of the bladder and renal pelvis clear it up. The second form is of unknown origin, affects young men mostly, rarely is found in women.

TABLE II

Cases	Duration of symptoms				Fistula			Course			Result			Remarks
	Less than 1/4 yr	Less than 1/2 yr	Less than 1 yr	More than 1 yr	Drain	Closed	Total	Good	Fair	Poor	Surgical death	Tuberculosis death	Tuberculosis present	
Division I Unilateral— Total														Surgical mortality=1 8%
169	21	19	35	81	101/27 (Not stated, 10)	53/4	33	76	39	34	3	3	39	
1 Localized— 40	5	5	6	18	23/6	17/0	6	27	8	5	None	None	None	See Table III
2 With involvement of the bladder— 64	8	9	19	26	35/6	26/1	7	28	25	11	1	1	8	
a Mild— 13	2	2	4	4	7/0	6/0	0	10	2	1	1 (embolism)	0	0	See Table IV
b Extensive 51	6	7	15	22	28/6	20/1 (Not stated, 3)	7	18	23	10	None	1 (meningitis)	8	See Table V
c With constriction of the ureter of the opposite kidney producing renal insufficiency 17	1	1	3	12	9/2 (Not stated, 4)	4/1	3	5	6	6	None	1	6	See Table VI
3 With involvement of the genital tract Total														
23	3	0	2	16	15/3	7/1	4	9	8	6	1	1	6	See Table VII
a With involvement of the epididymides 8	1	0	1	4	4/3 (Not stated, 1)	3/1	4	3	3	2	1 (poly-cystic)	0	2	See Table VII
b With involvement of the prostate and seminal vesicles 2	0	0	0	2	1	1	0		1	1		1 (miliary)		1 epididymo-epidymal ves. calectomy. Well 7 yrs, free from tbc
c With involvement of the epididymides, prostate, and seminal vesicles 13	2	0	1	10	10	3	0	6	4	3	0	0	4	See Table VII
4 With extra-urogenital tuberculosis 25	4	4	8	9	19/10	4/1	11	7	12	6	1	0	19	See Table VIII
a With involvement of lungs 17	3	1	7	6	13/8	4/1	9	5	8	4	1	0	14	See Table VIII
b With involvement of bones 4	1	2	1		2/1 (Not stated, 2)		1	1	2	1	0	0	4	
c With involvement of lungs and bones 4		1		3	4/1		1	1	2	1	0	0	1	1 dead from stroke, 5 yrs 1 dead from embolism, 5 yrs remaining kidney normal
Division II Bilateral— 12		1	2	9	5/7 (Not stated, 2)	2/0	7		2	10	1	4	7	See Table IX

and starts acutely with bladder symptoms and even terminal hematuria without fever or any constitutional disturbance. The inflammation, as found in kidneys removed in error for tuberculosis, is confined to the mucosa of the pelvis. Recent cultural studies on Rosenow's bouillon by Schaffhauser¹ were positive for a non-hemolytic streptococcus which, when in-

oculated into dogs, reproduced the disease in them. Wildbolz² in Switzerland observed 21 patients with amicrobic pyuria. Six were cured by simple irrigations and the 15 who resisted any form of antiseptic treatment (given for years to some) got well promptly after one or two injections of neosalvarsan (0.15 gram). So specific is neosarsphenamine

¹ Ztschr f urol Chir u Gynaek., 1937, 43 83-140

² J urol, 1937, 37 605-609

TABLE III.—DIVISION I UNILATERAL INVOLVEMENT
1. Localized (no involvement of the bladder)

Case No.	Symptoms	Drainage of wound	Fistula Duration	Postoperative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
1	Frequency and dysuria 3 yrs	O	O	Good	Caseoecavous tuberculous chronic inflammation of ureter		O	O
83	Pain in left lumbar region 3 yrs Frequency and nocturia 3 months Cloudy urine 7 mos	O	O	Good	Caseoecavous tuberculous No tubercles in ureter		X	X
9	Frequency and nocturia 2 yrs Hematuria and cloudy urine 1 yr Loss of 10 lbs in 1 yr	O	X 1 mo	Good	Caseoecavous tuberculous	Slight drainage from wound 20th postoperative day	O	O
96	Pain in bladder region 6 mos Frequency and nocturia dysuria hematuria 6 mos	O	X	Good	Caseoecavous tuberculous in upper pole	Wound broke down 7 wks after surgery	X	X
99	Dysuria and recurrent hematuria 1 yr Loss of 12 lbs in 8 mos Nocturia 2 mos	O	O	Good	Caseoecavous tuberculous		O	O
111	Nocturia to morn Cloudy urine 7 mos Hematuria 7 wks	O	O	Good	Caseoecavous tuberculous Dissection of ureter	Slight subcutaneous infection of posterior corner of wound. Healed promptly. Alive 24 yrs later	X	X
113	Dysuria and hematuria 7 wks	Rubber dam	O	Good	Caseoecavous tubercles in ureter	Well 3 yrs later	O	O
126	Pain in right lumbar region 3 mos Frequency and dysuria 6 mos	Rubber tube	O	Good	Tubercles in right kidney and small encapsulated adenocarcinoma in middle of kidney	Slight infection around rubber tube. Healed in 3 wks. Well 5 yrs later	X	O
154	Right lumbar pain 7 yrs	O	O	Fair	Caseoecavous tuberculous. Tubercles in ureter	Well 3 yrs later	X	O
159	Left lumbar pain 1 yr Frequency 8 mos Nocturia 6 mos Hematuria 5 mos	Rubber tube	X 30 d 3/4	Fair	Tubercles in upper pole of left kidney	Well 3 yrs later	X	X
139	Right lumbar pain 8 yrs ago Night dysuria 7 1/2 yrs ago—no evidence of tuberculous. Night dribbling all the time	Rubber tube	X 1 mo	Good	Caseoecavous tuberculous in upper pole of right kidney. Round fibrous mass in ureter		X	X
145	Right lumbar pain 13 mos Frequency nocturia and dysuria 3 yrs	Rubber tube	X 2 d 1/2	Good	Extensive caseoecavous tuberculous		O	O
157	Suprapubic pain 5 mos Frequency and dysuria 5 mos	Rubber tube	O	Good	Caseoecavous tuberculous in upper pole	Well free from tuberculous 3 yrs later	X	O
130	Frequency 6 mos	O	O	Good	Caseoecavous tuberculous. Three cysts in upper pole		X	X
65	Frequency and dysuria 3 yr	Rubber tube	O	Good	Tubercles. Small calculi	Slight infection around rubber tube. Healed promptly. Well and free from the 24 yr later	X	X
106	Frequency nocturia and dysuria 6 mos Hematuria 4 mos	Rubber tube	O	Fair	Diffuse caseoecavous tuberculous in ureter	Slight purulent drainage around rubber tube	X	X
107	Dull right lumbar pain 3 yrs Frequency and nocturia 3 yrs Hematuria once 2 yrs ago	Rubber tube	X 2 m 3	Fair	Caseoecavous tuberculous. Tubercles in ureter	Complete ureterectomy through ventral incision. Well 14 mos later	Good and free	X 14 mos
173	Frequency nocturia dysuria and dysuria 3 yr	Rubber tube	X 1 mo	Fair	Caseoecavous tuberculous	Developed duodenal fistula which closed spontaneously 20 days. Well 7 yrs later	O	O
175	Right lumbar pain 4 mos	Rubber tube	O	Good	Fibrosis of right kidney. Large calculus. Tubercles in ureter		O	O

TABLE III—DIVISION I. UNILATERAL INVOLVEMENT—Continued
 1 Localized (no involvement of the bladder)

Case No	Symptoms	Drainage of wound	Fistula	Post-operative course	Pathology	Remarks	Tubercles in urine from	
			Duration				Bladder	Kidney
182	Pain in left kidney region 5 mos Frequency, nocturia, and dysuria 10 mos	Cigarette drain	O	Good	Advanced caseocavernous tuberculosis		X	O
184	Pain in right groin 3 mos Dysuria 2 mos	Rubber tube	X 1 yr	Poor	Advanced caseocavernous tuberculosis. Tubercles in ureter	Carcinoma found in kidney. Recurrence of carcinoma in wound 11 mos later	O	O
188	Dull pain in right upper quadrant 4 mos.	O	O	Good	Tubercles. Large cyst in lower pole	Well and free from tuberculosis 9 yrs later	X Guinea pig	X Guinea pig
191	Frequency, nocturia, and dysuria 1½ yrs Intermittent hematuria 1 yr Cloudy urine 6 mos.	O	O	Good	Early caseocavernous tuberculosis	Patient well 6 mos later	X	X Guinea pig
225	Pain in right flank 32 yrs Frequency and urgency 3 mos Swelling in right flank 6 wks Pus in urine 16 yrs ago	Rubber tube	X 16 mos	Poor	Advanced caseocavernous tuberculosis	Associated with perinephritic abscess and the kidney was autolized. Well and free from tuberculosis 5 yrs later	O	O
231	Frequency and dysuria 9 yrs Pus in urine 5 yrs ago	O	O	Good	Early caseation		X	X
241	Suprapubic pain 1½ yrs Frequency, nocturia, and dysuria 1½ yrs Cloudy urine 1½ yrs Loss of weight 2 yrs	Rubber tube	X about 1 yr	Fair	Advanced caseocavernous tuberculosis	Associated with perinephritic abscess. Patient well 1 yr later	O	O
249	Pain in left lumbar region 4 yrs Cloudy urine 4 yrs Hematuria 4 days	O	O	Good	Advanced caseocavernous tuberculosis		O	O
256	Pain in left upper quadrant	Rubber tube	X 11 mos	Poor	Caseocavernous tuberculosis of left kidney	Remaining ureter removed 4 mos after nephrectomy and wound cured. Patient well 6 mos later	O	X
267	Pain in left kidney region 6 yrs Frequency 6 yrs	O	O	Good	Advanced caseocavernous tuberculosis	Well and free from tuberculosis 18 13 yrs later	X Guinea pig	X
273		Rubber tube	O	Good	Advanced caseocavernous tuberculosis. Tubercles in ureter		O	O
275	Pain in r l q left lumbar pain, hematuria 3 mos Loss of weight 2 mos	Rubber tube	O	Good	Caseocavernous tuberculosis		O	X
288			O	Good	Caseocavernous tuberculosis	Six mos later patient developed Hunner's ulcer	O	O
291		O	O	Good	Caseocavernous tuberculosis	Wound broke down 4 yrs later, healed after removal of remaining ureter. Patient well and free from tuberculosis 11 yrs later	O	O
292		Cigarette drain	O	Good	Tubercles in cortex		O	X
293	Backache 4 wks Chills 4 wks	Cigarette drain	O	Good	Advanced caseocavernous tuberculosis. Large calculus		O	O
299	Frequency, nocturia, and dysuria 8 mos Loss of weight 6 mos Hematuria 1 mo	O	O	Fair	Caseocavernous tuberculosis	Developed bilateral parotitis	X	O
330	Dull backache and pain in right lower quadrant 1 mo	Rubber tube	O	Good	Advanced caseocavernous tuberculosis. Calcification kidney completely destroyed	Right nephrectomy was done. Mild hydronephrosis of left kidney caused by kink at upper end of ureter. Cholecystectomy 2 yrs later. Patient well except for hypertension 4½ yrs later		
362	Frequency and nocturia 7 yrs Suppression of urine 1 mo Albumin and pus in urine for 7 yrs. Symptoms of uremia	Rubber tube	O	Fair	Advanced caseocavernous tuberculosis, complete destruction of right kidney. Ureter caseous	Bladder was normal. Left hydronephrosis—cause was not evident, not treated. 1 yr later marked hypertension on Albumin, casts, and pus in urine persist	O	O

TABLE III—DIVISION I UNILATERAL INVOLVEMENT—Continued
1 Localized (no involvement of the bladder)

Case No.	Symptoms	Drainage of wound	Fistula Duration	Postoperative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
163	Back injury 7 yrs. ago and 2 yrs. a mass in left side of abd. men. One year ago patient was told that left kidney was dead	Rubber tube	✓ 4 mos.	Poor	Complete necrosis and caseation. Necrosis and tubercles in ureter	Bladder normal. Cause of right hydronephrosis not evident and it was not treated. Hemorrhage occurred into left nephrectomy wound. Tuberculosis of right kidney in the blood		
150	Left lumbar pain 2 wks. Fever 10 days	Rubber drainage pack	✓ 48 days	Fair	Exfoliative caseous tuberculous	Left nephrectomy. Bladder negative. Right hydronephrosis caused by block in ureter. It was not treated. Perinephritic abscess was found. Patient well and had a baby 4 years later	0	0

TABLE IV—DIVISION I UNILATERAL INVOLVEMENT
a With mild involvement of the bladder

Case No.	Symptoms	Drainage of wound	Fistula Duration	Postoperative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
2	Suprapubic pain 2 mos. Dysuria 8 mos.	0	0	Good	Caseous non-tuberculous		✓	✓
7	Left lumbar pain and frequency 3 mos.	0	0	Good	Caseocavernous tuberculous		✓	✓
44	Frequency and dysuria 8 mos.	Rubber tube	✓ 7	Fair	Tubercles		0	✓
78	Right lumbar pain 7 mos. Night sweats 5 wks.	Rubber tube	0	Good		Well 5 yrs. later	0	0
120	Suprapubic pain 3 yrs. Frequency and dysuria yrs.	Pedicle clamp Left on	Death	Poor	Caseocavernous tuberculous	Died of pulmonary embolism	0	0
120	Emaciation since infancy now 3 yrs old	Rubber tube	0	Good	Caseocavernous tuberculous	Well no bladder trouble 4 mos. later	✓	✓
113	Hematuria and frequency 5 yrs. Bladder pain 3 yrs.	0	0	Good	Tubercles		✓ Guinea pig	✓
113	Left lumbar pain 6 mos. Frequency and dysuria 2 mos.	0	0	Good	N.I. stated		✓	✓
153	Right renal pain 3 yrs. Frequency and nocturia 1 yr.	Rubber tube	0	Good	Advanced caseocavernous tuberculous		0	0
20	Frequency and dysuria 3 yrs. Pyuria 6 mos.	Rubber tube	0	Good	Caseocavernous tuberculous		0	0
200	Frequency 4 mos. Hematuria 2 mos.	0	0	Good	Advanced caseocavernous tuberculous	Abscess in wound 3 mos. after operation healed promptly. Nephrectomy and ureterectomy	0	0
115	Frequency 1 yr. Hematuria and cloudy urine 2 mos. Left lumbar pain mos.	Rubber tube	0	Good	Massive caseocavernous tuberculous		0	0
171	Hematuria frequency and dysuria 2 mos.	0	0	Good	Small caseation at lower pole. Tubercles of pelvis and ureter	Well and free from tuberculosis 8 yrs.	✓	0

that Wildbolz advised its routine use in differential diagnosis.

During this study of an aseptic pyuria, a diligent search for tubercle bacilli is being carried on continuously by the well known methods of microscopic examination, inoculation of guinea pigs, and bacteriologic cul-

ture. According to Pelz,¹ the microscopic search demonstrates tubercle bacilli in 72 per cent, the guinea pig test, in 94 per cent and the Loewenstein method of culture or some modification of it, in 98 per cent. Cultural methods have largely replaced the use of

TABLE V.—DIVISION I UNILATERAL INVOLVEMENT
2b With extensive involvement of the bladder

Case No	Symptoms	Drainage of wound	Fistula	Post-operative course	Pathology	Remarks	Tubercles in urine from	
			Duration				Bladder	Kidney
12	Hematuria and frequency 4 mos Lumbar pain 1 wk	O	O	Poor	Caseocavernous tuberculosis	Patient well except for bladder symptoms 8 mos later	X	O
17	Lumbar pain 8 mos Hematuria and dysuria 2 mos	O	O	Good	Tubercles in kidney	Patient well 1 yr. later	X	X
20	Hematuria, frequency, and dysuria 1 yr	Rubber tube	O	Good	Caseocavernous tuberculosis		X	X
24	Frequency and dysuria 3½ yrs	Rubber tube	O	Good	Caseocavernous tuberculosis		X	X
39	Frequency 1 yr Dysuria 7 mos	O	O	Fair	Caseocavernous tuberculosis	Well 6 yrs later except bladder symptoms which are improving	X	X
42	Frequency, dysuria 9 mos. Cloudy urine 7 mos Hematuria 7 mos Suprapubic pain 2 mos	Rubber tube	O	Fair	Caseocavernous tuberculosis	Bladder symptoms persist	X	X
43	Frequency, dysuria 3 mos Hematuria and cloudy urine 2 mos Suprapubic pain 2 wks	O	X Still draining after 3 mos	Poor	Tubercles in cortex and lower pole		X	X
49	Hematuria 3 yrs renal tenderness	Rubber tube	O	Fair Ulcers fulgurated	Caseocavernous tuberculosis	Patient alive and well 9 yrs later	O	O
57	Frequency, dysuria 12 yrs Hematuria 6 mos Left lumbar pain 1 mo	O	O	Fair	H ₂ dronephrotic kidney with fibrosis	Patient returned for fulguration of bladder ulcers	X	O
60	Frequency 1 yr Hematuria 1 wk	O	O	Fair			X	O
61	Hematuria, frequency, and urgency 3 yrs Cloudy urine 1 yr Suprapubic pain 2 mos	O	O	Fair	Caseocavernous tuberculosis	Ulcers fulgurated intermittently for 3 yrs Patient well and free from tbc 4 yrs later	X	X
66	Frequency 5 yrs Hematuria and dysuria 4 yrs Marked loss of weight	Rubber tube	X Still draining 6 mos later	Poor	Caseocavernous tuberculosis	Nephrotomy for perinephritic abscess Nephrectomy 1 mo later	O	O
76	Nocturia 2 mos P ₃ uria	Rubber tube	X Over 2 mos	Fair	Caseocavernous tuberculosis	Much improved and seemed well 3 yrs later	X	X
86	Lumbar pain, frequency, and dysuria 12 yrs Cloudy urine and hematuria 6 mos	O	O	Fair	Caseocavernous tuberculosis	Patient appeared well 6 yrs later	X	X
97	Hematuria and dysuria 1 yr	O	O	Poor	Caseocavernous tuberculosis	Bladder symptoms persisted, prolonged treatment Apparently well 10 yrs later, although urine still showed occasional pus cell	X	X
105	Frequency, dysuria, and lumbar pain 2 yrs	Rubber tube	X 1 yr	Poor	Caseocavernous tuberculosis	Marked bladder symptoms, ulcers fulgurated 7 yrs later bladder healed but contracted	O	O
110	Pain in left lumbar region 1 yr Frequency, nocturia and dysuria 1 yr	Rubber dam	O	Fair	Caseocavernous the Round cell infiltration of ureter	Ulcers fulgurated intermittently for 2 mos Patient well in 7 mos	O	X
114	Pain at end of penis 6 mos Dysuria 2 yrs Frequency and nocturia 4 yrs	O	O	Fair	Ulceration of pelvis Tubercles in cortex	Ulcer fulgurated intermittently for 4 yrs. Well and free from tbc. in 8 yrs	X Guinea p ₃ s	O Guinea pig
117	Nocturnal emission on many years Urine showed pus cells	O	O	Good	Tubercles in cortex and ureter	Ulcers fulgurated a few times Patient well and free from tbc. 12 yrs later	X Guinea pig	X
121	Suprapubic pain 1 yr Hematuria, frequency, nocturia, dysuria, and cloudy urine 1 yr	Rubber tube	O	Fair	Caseocavernous tuberculosis Caseation and tubercles in ureter	Patient well 9 yrs later	X	O

TABLE V—DIVISION I UNILATERAL INVOLVEMENT—Continued
2b With extensive involvement of the bladder

Case No.	Symptoms	Drainage of wound	Fistula Duration	Post-operative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
127	Pain in left groin 3 yrs. Hematuria frequency and nocturia 3 yrs	Rubber tube	O	Poor	Advanced caseous cavernous tuberculous. Tubercles in ureter	Ulcer fulgurated. Young pus cells operative for a median bar 6 m later. Wound broke down 8 mos later. Wound was opened, cut out and it healed slowly. Patient alive 8 yrs later and is well except for pus cells in urine.	O	Guinea Pig
141	Frequency nocturia and dysuria 2 yrs. Polyuria 8 yrs	Rubber tube	X 1 mo	Fair	Caseocavernous tuberculous. Complete occlusion of ureter		O	O
150				Good	Tubercles in kidney		X Guinea Pig	X
153	Pain in right lower quadrant 3 mos. Frequency nocturia and dysuria 3 mos. Hematuria 2 mos. Loss of weight 6 mos	Rubber tube	O	Good	Caseocavernous tuberculous in upper half of kidney. Lymphocytic infiltration in ureter	Urinary symptoms disappeared after 1 yr. Toxic thyroid adenoma removed 2 yrs later. Patient free from the	X	O
155	Frequency and dysuria 4 mos. Hematuria 1 mo. Injury to back 5 mos ago	Rubber tube	X 1 mo	Fair	Caseocavernous tuberculous	Patient very well and urine negative 3 mos later	X	X
176	Pain in left lower quadrant 2 mos. Urgency 1 yr. Dysuria 6 mos. Pus in urine 6 mos ago	Rubber tube	O	Fair	Tubercles in cortex. Tubercles in upper portion of ureter	Patient well and free from tuberculous 8 yrs later	X Guinea Pig	X
178	Dull right lumbar pain 4 yrs. Hematuria frequency nocturia dysuria 2 yrs	Rubber tube	O	Good	Caseocavernous tuberculous. Tubercles in ureter	Patient very well 2 yr later. No urinary symptoms and urine negative 1 yr later	X	X
183	Left lumbar pain 1 yr. Frequency and dysuria 18 yrs. Swelling in left lumbar region 3 wks. Debility 1 yr. Loss of 40 lbs in 1 yr	Rubber tube	X 6 mos (still draining)	Poor	Left kidney a total	No evidence of kidney found at time of operation. Huge abscess drained. Pus from abscess positive for tuberculosis	O	O
185	Left lumbar pain 1 1/2 yrs. Pus found in urine 1 yr ago	Rubber tube	O	Good	Caseocavernous tuberculous in upper half	Patient improved 3 m later	X Guinea Pig	O Guinea Pig
189	Left lumbar pain 6 wks. Frequency nocturia and dysuria 7 mos	Rubber tube	X 3 m (still draining)	Fair	Caseocavernous tuberculous. Tubercles in ureter	Patient gained weight and urinary symptoms improved promptly	X	O
197	Hematuria frequency nocturia dysuria 3 yrs. Cloudy urine 5 mos	O	O	Good	Caseocavernous tuberculous. Mucosa of ureter is invaded	Bladder improved very much in 6 m	X	
201	Backache 3 yrs. Dysuria 4 yrs. Frequency and nocturia 3 yrs	O	O	Poor	Tubercles. Tubercles in ureter	Ulcers fulgurated 1 m recently for 3 yrs. Patient very well and free from the 6 yrs later	O Guinea Pig	X Guinea Pig
207	Pain in right upper quadrant 3 yrs. Frequency nocturia and dysuria 3 yrs	O	O	Fair	Advanced caseocavernous tuberculous	Urinary symptoms persisted for about 1 yr. Patient well and free from the 4 yrs later	O	O
208	Pain in right side 1 yr. Hematuria frequency nocturia dysuria 1 yr. Loss of weight 1 1/2 yrs	Rubber tube	O	Good	Advanced caseocavernous tuberculous with amyloid formation	Patient improved 5 mos later	X	O
209	Right lower back pain 6 m. Frequency nocturia dysuria 6 mos	O	O	Good	Caseocavernous tuberculous		O	O
214	Frequency and nocturia 4 mos	Prose	O	Good	Advanced caseocavernous tuberculous	Urinary symptoms improved in 2 yrs. Patient well and right kidney 2 yrs later. Patient is well 3 yrs later but nocturia (2 times) persists	X	X
217	Pain in right costovertebral angle 8 mos	Rubber tube	O	Good	Caseocavernous tuberculous. Tubercles in ureter		O	O

TABLE V.—DIVISION I UNILATERAL INVOLVEMENT—Continued

2b With extensive involvement of the bladder

Case No	Symptoms	Drainage of wound	Fistula Duration	Post-operative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
219	Right lumbar pain 1 yr Dysuria 8 mos Cloudy urine 2 wks	Rubber tube	X About 6 wks	Fair	Advanced caseocavernous tuberculosis Chronic inflammation in ureter		X	X
221	Suprapubic pain 6 mos Hematuria, frequency, nocturia 6 mos	Rubber tube	O	Good	Tubercles, fibrosis and slight caseation Chronic inflammation in ureter	Patient well and free from tuberculosis 4 yrs later	X	X
238	Pain at end of penis 3 yrs Frequency, nocturia 4 yrs Hematuria 3 yrs	Rubber tube	O	Good	Advanced caseocavernous tuberculosis	The involved kidney (left) was functionless	O	O
246	Right lumbar pain 4 mos Hematuria, frequency, nocturia, dysuria 4 mos Cloudy urine 4 mos	Cigarette	O	Poor	Ulceration of pelvis and tubercles in cortex Tubercles in ureter	Ulcers fulgurated intermittently for 3 yrs Patient's general condition is good 4 yrs later, but ulcers still persist	X	X
271	Cloudy urine 2 mos Hematuria, frequency, nocturia, dysuria 2 wks	Rubber tube	O	Poor	Caseocavernous tuberculosis	Patient died 1 mo later at S F County Hospital of tuberculous meningitis	O	Guinea pig
274	Frequency, nocturia, dysuria 1 yr Hematuria 3 mos	Rubber tube	O	Good	Advanced caseocavernous tuberculosis Cessation of ureter		X	X
281	Pain in right kidney region 1 mo Frequency and dysuria 3 mos Cloudy urine 1 mo			Fair	Caseocavernous tuberculosis	Bladder ulcers were troublesome for 1 yr Patient well 9 yrs later. Urine shows rare pus cell	X	X
285		Rubber tube	X 6 mos (died)	Fair	Advanced caseocavernous tuberculosis Ureter shows caseation	Complete ureterectomy was done through a ventral incision at time of nephrectomy Patient died of myeloid leucemia	O	X
295	Frequency, nocturia, dysuria, loss of weight 7 mos Fever 1 wk	O	O	Good	Caseocavernous tuberculosis Tubercles in ureter	Bladder ulcers fulgurated Patient improved promptly except for urinary frequency	X	X
297	Hematuria, frequency, nocturia, dysuria 2 1/2 mos	Penrose	O	Good	Advanced caseocavernous tuberculosis Chronic infection in ureter	Ulcers fulgurated	X	
257	Hematuria, frequency, nocturia, dysuria 2 yrs Cloudy urine 2 yrs Loss of weight 2 yrs			Fair	Advanced caseocavernous tuberculosis	Bladder ulcers persisted, in spite of intermittent fulguration, for 12 yrs Patient well 19 yrs later—no evidence of tuberculosis	X	O
258	Hematuria and cloudy urine 6 mos		X 4 mos	Fair	Caseocavernous tuberculosis	Urinary symptoms improved for 4 yrs, but became severe after that. Ulcers were fulgurated. Patient well except for frequency and nocturia 7 yrs later	O	
259	Hematuria and nocturia 2 yrs			Fair	Caseocavernous tuberculosis	Bladder ulcers were treated with irrigation and fulgurated 3 yrs later with good result. Patient developed active pulmonary lesion 1 yr later, which healed promptly Patient well 6 yrs later		
261	Frequency and dysuria 8 mos Hematuria 3 mos Loss of weight 3 mos	O	O	Fair	Advanced caseocavernous tuberculosis	Patient well 1 1/2 yrs later except for persistence of bladder symptoms	X	X Guinea pig

guinea pigs in which avian strains of tubercle bacilli are non-pathogenic. In my series of 300 patients, tubercle bacilli were found microscopically in 157. Of 62 patients tested by guinea pigs, 58 were positive. The cultural studies of the urine have been few and unsatisfactory. A diagnosis of renal tuberculosis was

made in 55 patients, and later confirmed by pathologic study, without tubercle bacilli ever having been found in the urine.

Let me discuss briefly the other condition a tubercle bacilluria without pus. It has been demonstrated indisputably, particularly since the advent of the newer cultural methods,

TABLE VI—DIVISION I UNILATERAL INVOLVEMENT

2c With involvement of the bladder and with constriction of the ureter of the opposite kidney producing renal insufficiency

Case No.	Symptoms	Dra n age of wound	Fistula Duration	Post operative course	Pathology	Remarks	Tubercles in ure from	
							Bladder	Kidney
151	Frequency and nocturia 4 yrs	Rubber tube	X 3 mo	Poor	Advanced caseocav- erous tuberculosis Cessation of ureter	Right nephrectomy Left ne- phroctomy—block at uretero- vesicular junction. E test un- proved rapidly. Died 10 yrs later	0	0
203	Hematuria frequency noc- turia dysuria 4 m 3	Rubber tube	0	Poor	Advanced caseocav- erous tube culosis	Bladder ulcer became extensive with very severe urinary sym- ptoms. Left ureterovesicular transplant in 10 later. Living and well 3 yrs later	X	X
218	Frequency nocturia and dysuria 10 yrs. Urgency 1 yr. Hematuria 3 mos Euresis 1 yr	Rubber tube	0	Good	Caseocavernous tuberculosis	Left nephrectomy Right ne- phroctomy Patient improved promptly and is well 4 yrs later. Bladder contracted and functionless		
247	Frequency nocturia dysuria and urgency 1 yr. Hema- turia 6 mos	0	0	Good	Caseocav- erous tuberculosis	Left nephrectomy Structure at right ureterovesicular junction Patient improved much in 1 mo	X	X
278	Frequency and nocturia 6 yrs	0	0	Good	Caseocavernous tuberculosis	Right nephrectomy Constriction at left ureterovesicular junction Tuberculosis of hip joint. Inter- mittent fulguration of bladder Urinary symptoms ceased 10 yrs later. Patient well 15 yrs later Right leg as being lengthened		
294	Pain in bladder 10 yrs Frequency nocturia dysuria urgency cloudy urine 1 1/2 yrs			Fair	Caseocavernous tuberculosis	Ureter fulgurated. Bladder capacity 30 c.c. Left nephrectomy 6 m 6 1/2 mos later. Patient improved	0	
300	Pain in right lumbar region 4 yrs. Frequency noc- turia and dysuria 4 yrs Cough 5 yrs	0	X 2 mo (Still draining)	Poor	Advanced caseocav- erous tuberculosis Cessation of ureter	Right nephrectomy Structure at left ureterovesicular junction Left nephroctomy at the same time under spinal anesthesia. Wound healed at first but it broke down in 4 mo	X	X
392	Pain in left side of abdomen Frequency and nocturia 1 yr. Dysuria 6 mos Hematuria 3 m 5. Swell- ing in scrotum 4 days	Rubber dam	0	Poor	Advanced caseocav- erous tuberculosis Cessation of ureter	Right nephrectomy Constriction of left ureterovesicular junction Lung became active	X	X
270	Pain in left kidney region 9 yrs. Frequency and noc- turia 9 yrs. Hematuria 5 y 3. Swelling of right epididymus 2 mo		0	Fair	Caseocavernous tuberculosis	Left nephrectomy Right hydro- nephrosis and contraction of ureterovesicular junction. Right nephroctomy 4 m 5 later Late at epididymectomy be- cause of fibrosis 1 yrs later		
244	Pain at end of penis Hema- turia frequency and noc- turia 1 1/2 mo. Swelling of left epididymus 7 mo. Tubercle bacilli found in urine 1 yr ago	Catheter	0	Fair	Advanced caseocav- erous tuberculosis	Right nephrectomy Constriction at left ureterovesicular junction became use of ureter tested and acted badly. Left epididymus moderate size. Stat and semi- nal vesicles adjusted	X	X
65	Frequency and nocturia 5 yrs		0	Poor	Caseocavernous tuberculosis	Bladder not improved in spite of intermittent fulguration. Left ureterovesicular junction tested 6 yrs later. Patient died of uremia 4 1/2 yrs after operation. Left semi- vaginal catheter placed in the ureterovesicular junction. Abscesses in kidney. No evidence of tuberculosis		
65a	Frequency dysuria and urgency 2 1/2 yrs. Hema- turia 2 yrs. Loss of weight 3 mos	Rubber dam	0	Fair	Caseocavernous tuberculosis	Right nephrectomy on 8-13-11. Left nephroctomy on 9-25-11. The kidney was found to be good at the time. In ph. stompy and its function improved rapidly. Left ureterovesicular transplant on 12-15-11. Patient well 3 yrs. later		

TABLE VI—DIVISION I UNILATERAL INVOLVEMENT—Continued
 2c With involvement of the bladder and with constriction of the ureter of the opposite kidney
 producing renal insufficiency

Case No	Symptoms	Drainage of wound	Fistula Duration	Post-operative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
107	Hematuria, frequency, nocturia		0	Good	Caseocavernous tuberculosis	Left kidney removed in 1917. Bladder ulcers persisted and capacity decreased to 20 c.cm. Right uretero-intestinal transplant 1-9-23. Patient improved. Right epididymectomy 6-19-23, this had to be followed by right orchidectomy because wound did not heal in 2 mos. Patient died at Central Emergency in February, 1924, of pneumonia.		
118	Frequency and dysuria 8 mos	Rubber tube	X 40 days	Poor	Left caseocavernous tuberculosis	Right nephrostomy and left epididymectomy 16 yrs later, bladder symptoms persisting	0	X
248	Frequency 17 yrs. Hematuria 10 yrs. Nocturia, dysuria, and urgency 4 yrs. Cloudy urine 10 yrs. Urine from both kidneys contained tubercles 4 yrs ago	Cigarette	0	Fair	Caseation at tips of calyces. Ulceration of pelvis	Right kidney has good function but urine from it shows pus cells and tubercles. Left kidney shows hydropnephrosis and poor function. Left nephrectomy. Epididymides, prostate, and seminal vesicles involved. Ulcers fulgurated intermittently for 1 yr. One year later a prostatic abscess broke into the urethra. Right nephrostomy 22 mos later. Kidney was grossly normal. Urine positive for tuberculosis. Patient died soon after with signs of uremia. No autopsy.	X	X
211	Pain in bladder 4 mos. Frequency and nocturia 6 mos. Loss of weight 1 yr	0	0	Fair	Caseocavernous tuberculosis of left kidney	Right kidney had good function. Urine from it contains tubercle bacilli. Left shows some hydropnephrosis and hydroureter. Right nephrostomy was done and kidney was grossly normal. Left nephrectomy was done 5 wks later.	X	X
232	Pain in right flank 4 yrs. Hematuria, frequency, nocturia, dysuria 6 yrs. Cloudy urine 1 yr. Pyuria 5 yrs ago	Cigarette	0	Good	Caseocavernous tuberculosis. Calculus. Caseation and fibrosis of ureter	Prompt improvement. Left hydro-nephrosis due to contraction and ulceration of bladder	X	0

that this condition exists frequently in all forms of extrarenal tuberculosis. A tubercle bacillema is just as frequent. That the kidney is not a bacterial filter has been firmly established also. Therefore, tubercle bacilli in the urine mean tuberculosis of the urogenital tract or of some structure in communication. Medlar started the controversy now under discussion when he demonstrated at autopsy bilateral tuberculous lesions of the kidneys in 23 patients in a series of 30 who died of pulmonary tuberculosis. None of these patients had had clinical evidence or signs of renal tuberculosis, such as pyuria. No doubt during life the urine of all 23 would have shown a tubercle bacilluria and the blood a bacillema. It has since been noted frequently, by various observers, that a bacilluria of this kind—that is

a bacilluria without pus—either with or without extrarenal tuberculosis, will disappear, and the inference that these early lesions have healed spontaneously is clear enough. To infer, however, because of these findings, that renal tuberculosis which clinically is so frequently unilateral, is actually bilateral at onset, is not so logical. I can see no reason why incipient or preclinical tuberculosis cannot involve one kidney and miss the other. The fact that staphylococcus nephritis is almost invariably unilateral has never been questioned. The invading staphylococci are carried by the blood from a furuncle or boil presumably in equal numbers to both kidneys, but only one suppurates. Why, then, in tubercle bacillema cannot one kidney be invaded and the other escape? Aside from this point

TABLE VII—DIVISION I UNILATERAL INVOLVEMENT

3 With involvement of the genital tract

a With involvement of the epididymides

Case No.	Symptoms	Duration of wound	Fistula Duration	Post-operative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
24	Epididymectomy 6 yrs Hematuria 1 1/2 yrs	O	O	Good	Caseocavernous tuberculous	Well 25 yrs. later	O	O
235	Right lumbar pain 3 yrs	O	✓ 3 mos	Fair	Tubercles in upper half of right kidney	Wound healed perineum and brok down in 2 mos. Right epididymectomy 1 yr later	O	✓
243				Poor		Left nephrectomy because of the n 1928. F eque cy and nocturia recurred 6 yrs later and bladder ulcers treated with irrig t s. Left ep didymo-orchitis 8 yrs later—right side cured completely. Patient well 6 yr later		
254	Dysuria 1 yr Pus found in urine	Rubber tube	O	Good	Caseocavernous tuberculous. Tubercles in ureter	Patient well 3 yrs later. Treated at sanitarium 1 flow; g surgery Right epididym orchiectomy and left epididymectomy 1 yr ago	✓ Guinea pig	✓ Guinea pig
264	Pus found in urine	Rubber tube	✓ 4 mos	Fair	Advanced caseocavernous tuberculous	Bilateral epididymectomy 5 yrs later. Patient well 1 1/2 years tuberculous 10 yrs later	✓	✓
286				Good	Caseocavernous tuberculous	Left epididymo-orchidectomy 14 yrs. later. Patient well and free from tuberculous 20 yrs later	O	O
290	Hematuria 1 1/2 yrs Frequency nocturia and dysuria 1 yr Swollen right testicle 7 yrs ago Swollen left testicle 1 yrs ago	Cls etc	✓ 1 mo	Fair	Caseocavernous tuberculous. Tubercles in ureter	Right epididymo-orchidectomy 2 yrs ago. Left epididymectomy and partial orchidectomy 6 mos ago. Ulcers are fully ligured internally and improved. Patient generally good 15 mos. later	✓	O
293	Suprapubic pain 1 mo Hematuria 4 mos F eque cy 2 mo	Rubber tube and gauze pack		Died 10 3 d ys	Caseocavernous tuberculous. Polycystic kidney	Right kidney was explored just before left nephrectomy and was found to be normal. Both testes and epididymides had been removed some time before nephrectomy. Patient died in uremia	O	O

b With involvement of the prostate and seminal vesicles

249	Pain in right lumbar region 1 mo Dysuria 1 mo Injury to right side of back 1 mo ago	Rubber tube	✓ about mo	Fair	Caseocavernous tuberculous. Stricture of ureter completely destroyed	Ulcers fulgurated intermittently 1 1/2 yrs. Left epididymectomy and bilateral seminal vesiculectomy 3 yrs later. Recurrence of peristalsis of bladder. Recurrence of suprapubic cyst tomy was done 3 yrs later. Patient well 7 yrs later	O	O
263	Right lumbar pain 4 m s Hematuria 4 m s Cloudy urine 4 mos	O		Poor	Advanced caseocavernous tuberculous	Because of continued fever the wound was explored a few weeks later. Nephritis was found in the wound but tuberculosis infected and did not heal. Patient died 2 m later of urinary tuberculous	O	O

c With involvement of the epididymides prostate and seminal vesicles

23	Frequency nocturia dysuria 3 yrs Hematuria 1 1/2 yr	Ciga etc	O	Good	Caseocavernous tuberculous	Right epididymectomy	O	O
38	Frequency dysuria 3 yrs with cloudy urine Hematuria 1 yr	Rubber dam	O	Poor	Caseocavernous tuberculous	Right epididymectomy for fulgurated seminal vesicles. Epididymo-orchidectomy 9 yrs later. For 2 yrs later showed involvement of other epididymis prostate and seminal vesicles. Still has severe urinary symptoms		
45	Frequency nocturia dysuria urgency cloudy urine 1 mo. Hematuria 3 mos	O	O	Good	Caseocavernous tuberculous	Left epididymoprostate and seminal vesiculectomy 3 m s after surgery. Patient died 6 yrs after	✓	X

TABLE VII.—DIVISION I UNILATERAL INVOLVEMENT—Continued

3 With involvement of the genital tract

c With involvement of the epididymides, prostate and seminal vesicles

Case No	Symptoms	Drainage of wound	Fistula	Post-operative course	Pathology	Remarks	Tubercles in urine from	
			Duration				Bladder	Kidney
156	Backache 1 mo Hematuria 16 mos Dysuria 1 yr Frequency 6 mos	Rubber tube	O	Fair	Caseocavernous tuberculosis	Bilateral epididymectomy and seminal vesiculectomy 6 mos later Wounds healed in 19 days Patient well 3½ yrs later	X	O
158	Right lumbar pain 2½ yrs Hematuria 6 mos Albumin and pus in urine 2½ yrs Pain in right testicle 3 wks	Rubber tube	O	Fair	Caseocavernous tuberculosis Tubercles in ureter	Bilateral epididymectomy, seminal vesiculectomy and partial prostatectomy 2 mos later Wounds healed promptly Patient well 9 yrs later	X	X
160	Left lumbar pain 6 mos Hematuria 6 mos Frequency, nocturia, and dysuria 6 wks Injury to back 6 mos ago	Rubber tube	X 2 mos	Fair	Caseocavernous tuberculosis	Bilateral epididymo-seminal vesiculectomy 3 mos later Wounds healed promptly Patient well and free from tuberculosis 3 yrs later Has nocturia 1 to 2 times	O	X
216	Hematuria, frequency, nocturia, dysuria 5 wks	Rubber tube	O	Poor	Caseocavernous tuberculosis Tuberculosis of epididymis	Left epididymectomy was done at time of right nephrectomy X-ray of chest was negative before surgery and showed miliary tuberculosis 2 to 3 wks after surgery Patient had signs of tuberculous peritonitis	X	X
230	Frequency, nocturia, dysuria 2½ yrs	Rubber tube	X 1½ mos	Poor	Caseocavernous tuberculosis Chronic inflammation of ureter	Intermittent fulguration of bladder for 3 yrs Left epididymectomy and bilateral seminal vesiculectomy 8 mos later Median bar resected 3 yrs later—tissue showed tuberculosis of prostate Bladder improved after 3 yrs 1 V urograms 3 yrs later showed good right kidney	O	O
95	Pain in left flank 2 yrs Frequency and dysuria 2 yrs Hematuria 2 yrs ago	O	O	Good	Caseocavernous tuberculosis in lower pole	Patient had tuberculosis of spine, which healed Indurated left epididymis, prostate, and seminal vesicles	O	O
200	Pus found in urine 3 yrs ago Hard lump in left epididymis 3 yrs Right scrotal swelling 2 wks	O	O	Good	Caseocavernous tuberculosis Tubercles in ureter Caseation in epididymis	Right epididymectomy done at the same time Patient well 6 yrs later	X	X
204	Frequency, nocturia, dysuria 4 yrs Hematuria 6 wks Swelling of both epididymides 4 yrs, one broke down	Cigarette	O	Fair	Extensive caseocavernous tuberculosis Tuberculous epididymitis	Bilateral epididymectomy done at the same time Scrotal wound healed slowly Patient improved very much in 3 mos	O	O
242	Pain in left testicle 2 mos Pain in left flank 13 yrs Nocturia 8 yrs	Cigarette	O	Good	Advanced caseocavernous tuberculosis	Bilateral epididymectomy 2 wks before nephrectomy	X	X
171	Pain in left upper quadrant 2 yrs	Rubber dam	O	Good	Tubercles in lower pole of right kidney and ureter	Bilateral epididymectomy and prostate-seminal vesiculectomy 5 yrs later	X	X

and the other possibility of bilateral invasion of staphylococci with spontaneous healing on one side afterward, the condition of tubercle bacilluria without pus is rare except with active extrarenal tuberculosis. There is always plenty of pus with clinical tuberculosis. Tubercle bacilli in the urine alone may be regarded as evidence of an incipient lesion. Such a lesion may heal with medical treatment. Nephrectomy would be in order only when the bacilluria persisted and increased

after years of observation. The viewpoint that renal tuberculosis is bilateral at onset and that it may heal spontaneously has little if any effect in actual practice on the treatment of renal tuberculosis. The majority of patients at the time of the clinical diagnosis have a unilateral lesion, which is the reason surgery is so successful. Of my 300 cases, 246 were unilateral and 44 bilateral. Ten patients had miliary tuberculosis. Furthermore no one has ever been able to prove that a renal lesion

TABLE VII—DIVISION I UNILATERAL INVOLVEMENT

3 With involvement of the genital tract

a With involvement of the epididymides

Case No.	Symptoms	Drainage of wound	Fistula Duration	Postoperative course	Pathology	Remarks	Tuberculosis as source	
							Bladder	Kidney
84	Epididymectomy 6 yrs Hematuria 2 1/2 yrs	O	O	Good	Caseocavernous tuberculosis	Well 15 yrs later	O	O
235	Right lumbar pain 5 yrs	O	X 3 mos	Fair	Tubercles in upper half of right kidney	Wound healed per trinum and broke down 1 mo later. Right epididymectomy 1 yr later	O	X
243				Poor		Left nephrectomy because of the in 1938. Frequency and nocturia recurred 6 yrs later and bladder ulcers treated with irrigations. Left epididymo-orchitis 8 yrs later—right abscessed completely. Patient well 9 yrs later		
254	Dysuria 1 yr. P. s. found in urine	Rubber tube	O	Good	Caseocavernous tuberculosis. Tubercles in ureter	Patient well 1 yr later. Treated at sanatorium following surgery. Right epididymo-orchidectomy and left epididymectomy 1 yr ago	X Gross	X Gross
264	Pus found in urine	Rubber tube	X 4 mos	Fair	Advanced caseocavernous tuberculosis	Left lateral epididymectomy 3 yrs later. Patient well free from tuberculosis 15 yrs later	X	X
286				Good	Caseocavernous tuberculosis	Left epididymo-orchidectomy 14 yrs later. Patient well and free from tuberculosis 20 yrs later	O	O
250	Hematuria 1 1/2 yrs. Frequent nocturia and dysuria 2 yrs. Swollen right testicle 2 yrs ago. Swollen left testicle 12 yrs ago	Cigar etc.	X 1 mo	Fair	Caseocavernous tuberculosis. Tubercles in ureter	Right epididymo-orchidectomy 2 yrs ago. Left epididymectomy and partial orchiectomy 2 mos ago. U. v. s. are fulgurated internally and removed. Patient's general condition good 15 mos later	X	O
283	Suprapubic pain 1 m. Hematuria 4 mos. Frequent 1 mo	Rubber tube and gauze pack		Died in 3 days	Caseocavernous tuberculosis. Polycystic kidney	Right kidney was explored just before it ruptured and was found to be a renal abscess and epididymides had been removed some time before nephrectomy. Patient died 1 week later	O	O

b With involvement of the prostate and seminal vesicles

140	Pain in right lumbar region 1 mo. Dysuria 1 mo. Injury to right side of back 2 mo ago	Rubber tube	X about 1 mo	Fair	Caseocavernous tuberculosis. Stricture of ureter completely destroyed	U. v. s. fulgurated intermittently for 1 yr. Left epididymectomy and bilateral seminal vesiculectomy 3 yrs later. Because of persistent bladder ulcers and bleeding suprapubic cystotomy was done 2 yrs later. Patient well 7 yrs later	O	O
203	Right lumbar pain 4 m. Hematuria 4 mos. Cloudy urine 4 mos.	O		Poor	Advanced caseocavernous tuberculosis	Because of continued fever the wound was explored a few weeks later. Nothing was found in the wound but it became infected and did not heal. Patient died 4 mos. later of military tuberculosis	O	O

c With involvement of the epididymides, prostate and seminal vesicles

13	Frequency nocturia dysuria 3 yrs. Hematuria 1 yr	Cigar etc.	O	Good	Caseocavernous tuberculosis	Right epididymectomy	O	O
38	Frequency dysuria 1 yr with cloudy urine. Hematuria 1 yr	Rubber dam	O	Poor	Caseocavernous tuberculosis	Return of frequency of fulguration of bladder 3 yrs later. 1 yr later shows involvement of the prostate gland. Seminal vesicle biopsy has severe urinary symptoms		
43	Frequency nocturia dysuria ureteric cloudy urine 1 m. Hematuria 3 mos	O	O	Good	Caseocavernous tuberculosis	Left epididymectomy 2 yrs and seminal vesicles are indurated. Bladder ulcer fulgurated 3 mos after surgery. Patient alive 6 yrs after	X	X

TABLE VIII—DIVISION I UNILATERAL INVOLVEMENT—Continued

4 With extra-urogenital tuberculosis

a With involvement of lungs

Case No	Symptoms	Drainage of wound	Fistula Duration	Post-operative course	Pathology	Remarks	Tubercles in urine from	
							Bladder	Kidney
169	Pain in bladder 6 mos Frequency, nocturia, and dysuria 1½ yrs Loss of weight 6 mos.	Rubber tube	X 1½ mos (still draining)	Poor	Caseocavernous tuberculosis Tubercles and ulceration of ureter	Pulmonary signs became worse after surgery. Urinary symptoms persisted 1½ mos later	O	O
195	Swelling in right side of scrotum 7 mos	Rubber tube	O	Good	Caseocavernous tuberculosis Tubercles in ureter	Bilateral epididymectomy, seminal vesiculectomy and partial prostatectomy 5 wks after nephrectomy. All incisions healed promptly	X	X
210	Pain in right flank 2 mos Frequency and nocturia 1 yr Hematuria 3 mos Chills and fever 2 wks	O	X 1 year	Fair	Early caseocavernous tuberculosis Tubercles in ureter	Wound broke down 1 mo after nephrectomy and fistula persisted 1 yr 1½ urogram 1 yr after surgery showed mild obstruction at the ureterovesicular junction and left nephrostomy was done Left kidney appeared to be normal Wound healed	O	X

b With involvement of bones

46	Dysuria and cloudy urine 1 yr Frequency and nocturia 9 mos	Rubber tube	X	Fair	Caseocavernous tuberculosis	Active lesion of spine	X	X Guinea pigs
151	Backache 3 mos Hematuria, frequency, nocturia, and dysuria 6 mos	Rubber tube	O	Good	Early caseocavernous tuberculosis Tubercles in ureter	Pelvic bone involved Tuberculous glands removed from neck 7 yrs ago	X	X
235	Backache 6 mos Pus in urine			Fair	Caseocavernous tuberculosis	Both epididymides, prostate, and seminal vesicles nodular Dorsal vertebra involved Patient had an Abbe operation 6 mos ago		
230	Frequency, nocturia, dysuria 3 mos Albumin found in urine 6 wks ago			Poor	Caseocavernous tuberculosis	Spine involved Psoas abscess was found at the time of nephrectomy		

c. With involvement of lungs and bones

113	Right renal colic 16 mos ago Dull right lumbar pain 16 mos Dysuria 1½ yrs Hematuria and frequency 4 mos	Rubber tube	X 49 days (slight drainage)	Fair	Caseocavernous tuberculosis Caseation of ureter	Patient was well for 1 yr and then developed bilateral epididymitis Patient improved very much after 3 yrs Died 5½ yrs later of a stroke	X Guinea pigs	O
4	Pain in left groin Frequency, dysuria, and cloudy urine 1 yr Hematuria 6 mos	Rubber tube	O	Good	Caseocavernous tuberculosis in lower pole	Prompt improvement	O	
116	Pain in bladder 6 mos Frequency, nocturia, and dysuria 6 mos Dribbling 6 mos Trauma to scrotum 4 yrs ago	Rubber tube	X (1 month) Died	Poor	Caseocavernous tuberculosis Leucoplakia of pelvis Tubercles and caseation in ureter	Bilateral epididymectomy 24 days following left nephrectomy Patient died 5 days later of pulmonary embolism At autopsy, the right kidney was found to be normal	X	O
177	Right low lumbar pain 2 yrs Frequency and dysuria 2 yrs Urgency 1 yr	Rubber tube	O	Fair	Advanced caseocavernous tuberculosis Tubercles in ureter	Supravaginal hysterectomy 1 mo before nephrectomy Examination of this specimen gave clue to diagnosis of tuberculosis Bladder showed many ulcers	O	O

which has once discharged pus and organisms into the urine has healed except by autonephrectomy

The point in diagnosis, therefore, is to differentiate between the preclinical and incipient forms of tuberculosis of the kidney—the treatment of which is mostly medical—and the

clinical form—the treatment of which is surgical. In addition, to make the diagnosis complete, all associated lesions must be recognized. To paraphrase Kipling. He knows not renal tuberculosis who only renal tuberculosis knows The whole extent of tuberculosis in the patient must be known. With a complete

TABLE VIII—DIVISION I UNILATERAL INVOLVEMENT

4 With extra urogenital tuberculosis

a With involvement of lungs

Case No	Symptoms	Drainage of wound	Fistula Duration	Post operative course	Pathology	Remarks	Tubercles in urine from	
							Bled for	Exuberant
9	Frequency and urgency 4 yrs Hematuria 3 mos Dysuria 3 yrs	O	O	Fair	Advanced caseocavernous tuberculous	Uterus fulgurated internally for 5 yrs Bilateral tuberculous epididymitis 5 yrs later	O	O
10	Left lumbar pain 2 mos Hematuria and nocturia 2 wks Dysuria 3 yrs Loss of weight 2 mos	Rubber tube	X 4 mos (still draining)	Poor	Caseocavernous tuberculous	Wound opened 2 mos later and remaining portion of ureter explored. It was normal and was not removed	X	O
15	Backache 8 mos Frequency nocturia 1 yr Loss of weight 2 yrs Dysuria and cloudy urine 2 1/2 yrs	Rubber tube and catheter	O	Good	Tubercles in cortex Tubercles in ureter		O	Guinea pig
19	Left lumbar pain and swelling 1 mo Hematuria 5 yrs Dysuria 5 yrs Frequency 3 yrs	Rubber tube	X 3 mos (still draining)	Poor	Caseocavernous tuberculous	Left peritoneal abscess drained 3 wks before ligatures on became more active	Guinea pig	O
61	Bilateral lumbar pain 9 mos Frequency 3 mos Loss of weight 3 mos	O	O	Good	Caseocavernous Subacute urethritis	Peritonitis 14 yrs later	Guinea pig	Guinea pig
74	Pain in both lumbar regions Frequency and dysuria 6 mos	Rubber tube	X 1 mo (still draining)	Fair	Caseocavernous tuberculous		X	X
133	Pain in left iliac region 5 mos Hematuria 1 yr Cloudy urine 1 yr	Rubber tube	X 30 days	Fair	Caseocavernous tuberculous Lesion of pelvis Tubercles in ureter	Patient has healed tuberculous right hip	X	O
136	Pain in left upper quadrant 5 mos Frequency and nocturia 8 mos Cloudy urine 8 mos Swollen ankles 1 wk	Rubber tube	X 5 weeks (still draining)	Fair	Caseocavernous tuberculous	Urinary symptom persists Patient in sanatorium	O	Guinea pig
137	Hematuria Frequency dysuria and cloudy urine 5 mos Loss of weight 6 mos	Rubber tube	X 1 mo (still draining)	Fair	Cystic venous tuberculous	Apical nephritic abscess in the posterior pole of the kidney at the time of nephrectomy	O	O
68	Hematuria 2 mos	Rubber tube	X	Fair	Advanced caseocavernous tuberculous Lesion of subcapsular capsule	Patient in sanatorium and is improving Hematuria ceased	Guinea pig	X Guinea pig
17	Dysuria 3 wks Swelling of right testis 3 wks Frequency 3 wks Hematuria 3 wks	Catheter	O	Good	Early caseocavernous tuberculous Lesion of subcapsular capsule	Two years later patient had nephrectomy and peritonitis. Right kidney normal 3 yrs later Patient well	O	O
39	Gravel and abdominal pain 2 mos Frequency dysuria and cloudy urine 1 mo	O	O	Good	Caseocavernous tuberculous	Patient improved promptly	X	O
31	Frequency nocturia dysuria and cloudy urine 2 mos Loss of weight 2 mos Urinary retention 10 days	Rubber tube and gauze pad	O	Fair	Lamellar tuberculous Tubercles in ureter	Urinary symptom persists Right epididymitis drained	O	O
87	Frequency nocturia 3 wks Loss of weight 6 mos Pain in right iliac region 3 wks	Rubber tube	O	30 days	Caseocavernous tuberculous Left kidney autopsied	Uterus fulgurated and bladder was ruptured 5 years before cystitis was done. Right kidney was enlarged and had tubercles in the pelvis. Left kidney was normal. Patient died of uremia. Both kidneys were tuberculous. On the tuberculous pelvis of the right kidney was a tuberculous abscess.	X	

TABLE IX.—DIVISION II BILATERAL INVOLVEMENT—Continued

Case No	Symptoms	Drainage of wound	Fistula	Post-operative course	Pathology	Remarks	Tubercles in urine from	
			Duration				Bladder	Kidney
133	Pain in lower back 4 mos Hematuria, frequency, nocturia, dysuria, and cloudy urine 4 mos.	Rubber tube	X 2 mos (still draining)	Poor	Tubercles in cortex	Urine from both kidneys showed tuberculosis. Left kidney function good, few pus cells seen in urine from it. Right kidney function very poor, urine from it loaded with pus cells. Right nephrectomy was done. Lung lesion became very active after surgery. Patient died of tuberculosis about 2 mos later.	X	X
148	Pain in left kidney region 4 days. Frequency, nocturia, dysuria 5 mos.	O	O	Poor	Tubercles in cortex	Patient well for 5 yrs. Returned because of hematuria. Ulcers then fulgurated intermittently 7 yrs. later ulcers looked like Künner's ulcer, urine negative for tuberculosis. At this time, following fulguration, urinary extravasation occurred and suprapubic cystostomy was done. 2 mos later perinephric abscess, which was drained. Died of uremia. Remaining kidney showed caseocavernous tuberculosis, lungs chronic tuberculosis.	O	O
9+	Pain in left flank 6 mos Hematuria 1½ yrs. Nocturia 6 mos.	Rubber tube	X 5 mos (still draining)	Poor	Caseocavernous tuberculosis of left kidney	Urine from both kidneys contains tubercle bacilli. Right kidney, good function, left kidney, very poor function. Left nephrectomy. Both epididymides nodular 5 mos later, patient improving.	X	X

diagnosis in this sense one can classify clinical tuberculosis of the kidney into the 5 groups as shown in Table I.

The foregoing subdivision of patients is important in settling the argument of medical versus surgical treatment. A spontaneous cure is most likely in patients in whom the lesion is confined to one kidney. At the same time, removal of this kidney before the lesion has spread elsewhere might cure all of these patients, or at least more than are cured when associated lesions are present. This group (i.e., patients with localized unilateral involvement) is most favorable therefore for both medicine and surgery, and the answer to the question, "which is preferable?" should be found in a comparison of end-results. There has not been time to complete my follow-up records. As it stands, 66 patients had localized renal lesions (Table I) and unilateral nephrectomy was done promptly in 40. All of these 40 patients were alive and none of them showed any evidence of tuberculosis when last examined. Perhaps many of the 32 patients in the group not operated on have had their kidneys removed elsewhere, and it is possible that only a few of those who did not have such surgery, have received adequate medical care.

It would be instructive to know what happened to those who had proper medical care. Nevertheless we do know that in this group of patients who had no involvement of the bladder or elsewhere, nephrectomy was time-saving, safe, and entirely satisfactory. No flare-up or spread of tuberculosis occurred after nephrectomy. In comparing the duration of symptoms in the four subdivisions of the unilateral group, it is seen that the diagnosis in those patients who had tuberculosis limited to one kidney, and clean bladders, was made no earlier than in those who also had active tuberculosis of the bladder or genital tract, phthisis or tuberculous osteomyelitis, alone or in some combination (Table II). Barely 40 per cent of patients with localized renal tuberculosis had had symptoms less than 1 year and only 3 for less than 3 months, whereas in the 129 with vesical, genital, and other lesions, symptoms had been present for less than 3 months in 15 and for less than 1 year in 59. In other words, those patients in whom the tuberculosis was localized in one kidney seem to have had as much chance to develop bodily resistance and a general immunity to the infection as the others. The fact that the infection was confined to one kidney in these pa-

TABLE IX—DIVISION II BILATERAL INVOLVEMENT

Case No	Symptoms	Drainage of wound	Fistula Duration	Post operative course	Pathology	Remarks	Tuberculous mass from	
							Bladder	Kidney
164	Pain in lumbar region 5 yrs. Frequency and nocturia 7 yr. Draining sinus in neck 3 yrs.	Rubber tube	✓ 4 mos.	Poor	Spectrum obtained at time of left nephrectomy showed caseocavernous tuberculosis	Right kidney has no function. Left hydronephrosis with several constrictions in ureter. Left nephrostomy was done and kidney function improved. Left's renal calicular point involved. Right epididymus nodular, it drained 20 yrs. ago and gradually closed. Continued running fever died 8 mos. later.	0	0
77	Enuresis 2 yrs. Frequency and nocturia 6 mos. Loss of weight 2 mos. Latent fever	0	Patient died		Advanced caseous tuberculosis of left kidney. Tubercles and necrosis of ureter.	Left kidney functionless. Right kidney has good function on ureter from it shows no pus cells but positive for tubercles. Patient died 6 months after surgery. No autopsy.	X Guinea pig	X Guinea pig
115	Hematuria frequency nocturia and dysuria 4 yrs.	X	✓	Poor		Left nephrostomy was done and calculus removed. V band did not heal and nephrostomy was done about 6 mos. later. Left recurrent fulgurant on of bladder for 4 yrs. Right pyelonephritis and evidence of ureter 4 yrs. later. Tubercle bacilli not found. Patient died of urinary tuberculosis 4 yrs. later. No autopsy.	✓ Guinea pig	0
128	Left renal pain 13 yrs.	Rubber tube	0	Fair	Caseocavernous tuberculosis of upper pole healed with a renal calculus. Heminephrectomy.	Opposite kidney removed 7 yrs. ago for tuberculosis.	X Positive guinea pig	✓
102	Pain in left flank 4 yr. Hematuria 1 yr. Frequency nocturia dysuria and urgency 2 mos. Loss of weight 6 mos. Passed a small stone with urine 4 mos. ago.	Rubber tube	✓ 33 days	Fair	Caseocavernous tuberculosis with complete destruction of kidney. Chronic inflammation in ureter.	Right kidney functionless. Left kidney has good function. Pyelonephritis. Interventricular fulgurant on of ureters. Patient improved 3 yr. later a very healed tumor on the renal pelvis. Died of tuberculosis and renal insufficiency.	0	0
161	Hematuria, frequency nocturia, and cloudy urine 5 yrs. Loss of weight 3 yrs. by passes 4 mos.	Rubber tube	X Died 3 mos. after of urinary tuberculosis.	Poor	Large abscess of upper pole. Caseocavernous tuberculous abscess. Lymphocytic obliteration of ureter.	(1) Nephropathy cystotomy was done because an attempt at cystostomy examination revealed rupture of an aneurysm wall. (Bladder) (2) Urine from both kidneys was loaded with pus cells. Right kidney was functionless and left had fair function. Right a pyelotomy was done 3 mos. later. Urinary tuberculosis developed. Died. At autopsy left kidney showed caseocavernous tuberculosis.	0	0
190						Right nephrectomy because of tuberculosis. Bladder symptoms cleared in 3 yrs. 4 yrs. later frequency and nocturia occurred. Left nephrectomy and removal of lower pole done. Lower H showed caseocavernous involvement upper half was in testes 4 weeks later.	✓	✓
234	Frequent nocturia dysuria		✓ 53 yr.	Poor		Right nephrectomy because of tuberculosis. Right ureterectomized 4 yrs. later. Wound healed. Bladder contracted. Left epididymus 6 yrs. later. Interstitial fibrosis of bladder. Transurethral resection 3 yrs. later—tissue showed no tuberculosis. Patient died of a non-specific infection in left bladder 13 yrs. later.	0	0
170	Hematuria and dysuria 3 wks. Mass in right lumbar region 3 wks. and perinephritic abscess was drained.	Rubber tube	X Patient died after 5 wks.	Poor	Renal tissue obtained at time of nephrectomy showed caseous	Hemorrhage in right kidney not tuberculous. It marked hydronephrosis. Right epididymus was done and because of signs of uremia left nephrectomy was done 2 wks. later. Developed uremia and hemorrhage in both kidneys showed caseocavernous tuberculosis. Also re tuberculous of pleura pericardium, and peritoneum.	0	0

that portion of the ureter which was not removed. Nine of 38 patients on whom Beer¹ did extensive ureteronephrectomies developed sinuses in the lumbar wound and only 3 of the 38 had a sinus form in the rectus incision through which the ureter had been enucleated; all 3 were explainable on the basis of contamination of the wound at the time of ureterectomy. An attempt to remove the whole ureter is unnecessary, and the additional surgery required for it may be detrimental.

CONCLUSIONS

The conception that renal tuberculosis is bilateral at onset, that in the majority one side heals spontaneously leaving a unilateral lesion and that occasionally both sides may so heal, should have no effect whatsoever upon the management of clinical renal tuberculosis.

This conception, however, necessitates more than ever the differentiation of preclinical and other forms of tuberculosis of the kidney—such as miliary tuberculosis—from the clinical forms of the disease.

The finding of pus and tubercle bacilli in the urine points definitely to the clinical form of renal tuberculosis. The diagnosis is not complete, however, until all possible associated lesions have been searched for and recognized.

¹Ann Surg, 1936, 104 748-751

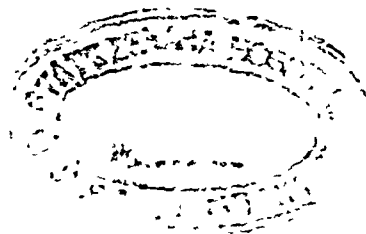
The urological examination must be precise with every precaution against spreading the infection. For this reason, the routine use of retrograde pyelography is condemned.

The clinical form is unilateral in over 85 per cent of patients when first diagnosed, but in relatively few of these has it remained confined to the kidney. Involvement of the bladder is common and genital and extra-urogenital lesions occur frequently in association with the renal lesion.

World-wide experience demonstrates the superiority of nephrectomy in the treatment of unilateral tuberculosis of the kidney. When tuberculosis is localized in the kidney and the patient has been properly prepared, nephrectomy is almost 100 per cent curative. When associated lesions exist in the bladder, seminal tract or elsewhere, nephrectomy is still from 60 to 70 per cent curative.

Nephrectomy is rarely an emergency procedure and should be performed only after a complete study and careful preparation.

An attempt should be made to perform a clean extracapsular enucleation by the extra-peritoneal lumbar route during which the kidney should be squeezed and manipulated as little as possible. Clamping of the pedicle should be the first objective. As much of the ureter as is accessible should be removed but a complete ureterectomy is unnecessary.



tients may indicate even a greater immunity. Furthermore, comparison of the condition of the kidneys which have been removed shows that the lesions in the kidneys of the patients with localized tuberculosis are as a rule as far advanced as those in the kidneys of patients with generalized tuberculosis.

The point I wish to emphasize, one often mentioned by urologists but never sufficiently recognized generally, is that the removal of a kidney in which tuberculosis is primary (i.e. there is no active tuberculosis elsewhere) before the infection has spread to the bladder is almost 100 per cent curative, whereas its removal after the bladder has become involved is little more than 60 per cent curative. I am speaking of clinical tuberculosis, the diagnosis of which is based on the finding of pus and tubercle bacilli in the urine and in which the pathologist will usually find a caseocavernous lesion.¹ The importance of not confusing this condition with preclinical tuberculosis of the kidney with which an active tuberculosis elsewhere is usually associated, is obvious.

The superiority of surgery in the treatment of clinical renal tuberculosis is found in the published records for the past 30 years of clinics throughout the world. For example, Hryntschak² of Vienna reported recently that 60 per cent of all his patients were well and free of tuberculosis 10 years after nephrectomy, whereas only 24 per cent of those not operated on were alive 12 years later and every one of them was still suffering severely with tuberculosis. This year Gile³ analyzed the known results in 84 of 93 nephrectomies in Squier's clinic, New York (there was no follow up record in 9). Fifty two of the 84 patients (31 of whom had extra urinary tuberculosis) are living and free of tuberculosis. Such statistics could be multiplied indefinitely.

The surgical risk of nephrectomy for renal tuberculosis is small, in my series there were 4 deaths from operation in 181 nephrectomies, 1 from embolism, 1 from shock, and 2 from uremia, of the latter, 1 patient had polycystic kidneys and the other had bilateral tuberculosis. Nephrectomy is rarely, if ever an

emergency procedure. The question of pre-operative preparation, its character and duration should be considered separately for each patient and should be answered according to his physical and economic situation. Sanatorial treatment is beyond the reach of some unnecessary for others. In any event, if adopted, the patient should understand that it is pre-operative. Any patient with acute symptoms, particularly fever, should have preparation by rest, fresh air, and over feeding even if only for 10 days or 2 weeks, and those patients in the group with primary tuberculosis limited to one kidney are no exception. It is a mistake, however, to attempt a cure of these patients by medical means just because the tuberculosis is limited. The risk of causing military tuberculosis at the time of operation is no greater in this group than in the others if the patient is prepared and the operation is not performed until after the very acute symptoms have subsided.

The risk that the remaining kidney will become tuberculous after nephrectomy is also small. Wildbolz, in an experience with over 600 nephrectomies, found the incidence to be less than 1 in 100 only 5 developing infection in the second kidney later. This rather nullifies the idea that renal tuberculosis is bilateral at onset. In a group of 17 patients (Table I, Division I, subdivision 2 subgroup c) with involvement of the bladder so extensive as to impair the function of the remaining kidney, subsequent examination of the kidney at the time of nephrostomy in 6 and at autopsy in 2 showed no tuberculosis. The incidence of a persistent sinus after nephrectomy, however, remains high. A sinus persisted longer than 2 months in 26 of 95 patients in whom a drain was inserted and a sinus developed in 4 of 60 in whom closure was done without drainage (Table II). As a rule an extracapsular encapsulation of the kidney was attempted and usually when the capsule had been adherent or pus had been spilled into the wound, a drain was inserted. The few cases of formation of a sinus after tight closure therefore cannot be used as an argument in its favor. It is my impression that a sinus usually persists or forms because of tuberculosis of perirenal tissues and rarely because of tuberculosis of

¹ P. H. Logg, *Report of 162 nephrectomies in caseocavernous lesions of the kidney*, *Ann. Surg.* 1935, 43, 24-316.
² Hryntschak, *Report of 1035 cases of renal tuberculosis*, *Ann. Surg.* 1935, 43, 24-316.
³ Gile, *Gynec. & Obstet.* 1935, 64, 1046-1050.

increased in acute pancreatitis. The increase in diastase is frequently demonstrable within 6 to 8 hours after onset of the acute disease and diminishes or disappears after 2 or 3 days; the augmentation of the serum lipase is produced only 2 or 3 days after onset but continues for quite some time, 1 to 4 weeks, at an abnormal level. These tests constitute valuable corroborative aids when facilities for their performance are available.

Sex and age. Of the 30 cases observed by us, 14 occurred in men and 16 in women. The average age of the patients was 40.7 years, 1 being in the second, 4 in the third, 7 in the fourth, 7 in the fifth, 9 in the sixth, 1 in the seventh and 1 in the eighth decades.

Previous history. Twenty-two gave a history of gall-bladder disease varying in length from 3 months to 20 years with an average duration of 3 years and 5 months, 14 gave a history of previous colics and 8 of colic immediately preceding onset of pancreatitis. Two had had cholecystostomies with removal of stones, one 6 years and one 8 months, and 3 had had drainage for acute pancreatitis, one 4 years, one 4 months, and one 8 months before present illness.

Duration of symptoms referable to pancreatic involvement. These had existed in 1 for 1, in 5 for 2, in 8 for 3, in 3 for 4, in 4 for 5, in 5 for 7, in 1 for 6, in 1 for 10, in 1 for 14 and in 1 for 16 days. In 18 the symptoms developed in from 1 to 4 weeks following gall-bladder colic, in 14 the initial pain represented the only colic.

Pain. The pain was noted as severe, accompanied with nausea and vomiting in 21, being of the hyperacute type in 9; in the remaining 9 while the onset was similar it was of milder degree. The pain was located in the epigastrium and right hypochondrium in 14, in the left hypochondrium in 5, and extended across both upper quadrants in 11. Cyanosis was noted in 2 and jaundice in 3. No patient was seen in profound shock, doubtless due to the period of time elapsing between onset of illness and period of observation. The pulse in 9 was below 100 and in 21 ranged from 100 to 140. The temperatures varied from 99 to 104 degrees. The leucocyte count in 9 was below 10,000 and in 21 ranged from 10,000 to 44,200.

Urine. The urine in all showed the presence of albumen; none showed the presence of sugar. Bile was present in 8, casts in 6, blood in 10, and pus in 13.

Mass. In 17 no mass was detected, while in the 13 remaining an enlargement was distinctly palpable, being located in the right upper quadrant in 7, in the left upper quadrant in 2, and in 4 it lay transversely across the epigastrium.

Pre-operative diagnosis. The diagnosis in 14 was acute cholecystitis, in 12 acute pancreatitis, in 2 acute appendicitis, in 1 intestinal obstruction, and in one "acute abdomen."

Morbid anatomy. Free fluid was found in the greater peritoneal cavity in 8, being bile-tinged in 3; hemorrhagic fluid exudate was present in the lesser peritoneal cavity in 15, varying in amount from a few to 2,600 cubic centimeters. Demonstrable fat necrosis existed in 15. Recognizable disease was present in the gall bladder in 24, calculi in the gall bladder in 18 and in the common duct in 2. The gross lesions of the pancreas presented as acute edema in 9, as acute necrosis in 10, as hemorrhagic pancreatitis in 9, and as pancreatic abscess in 2, there being a wide variety of findings apparently depending upon the stages at which the patients came to operation. In the cases of acute pancreatic edema the swelling of the organ increased its size to two or three times the normal, the consistencies varying from soft to almost stony hardness. Edema, differing in degree, was noted in the omental, mesenteric, and adjacent retroperitoneal tissues, in one instance extending throughout the mesentery of the ascending and transverse colon; the edema in the tissues about the common duct in some of the cases produced marked distortion of anatomical relations.

The primary lesion in pancreatic necrosis starts in the lobule and may be limited to one part of the organ or may involve a considerable portion of it. Sloughs containing devitalized pancreatic tissue may be removed at operation or may be extruded later from the drainage tract. In the cases of hemorrhagic pancreatitis the extent of the hemorrhage depends upon the size and number of vessels

ACUTE PANCREATITIS

IRVIN ABELL, M A, M D, F A C S, Louisville Kentucky

IN an experience embracing approximately 2,000 operations on the biliary tract, the writer has encountered 30 cases of acute pancreatitis. The term "acute pancreatitis" as here employed covers four clinical pictures—acute pancreatic edema, acute pancreatic necrosis, acute hemorrhagic pancreatitis, and pancreatic abscess—which are not separate clinical entities but are believed to represent different stages of the same process. It is worthy of note that the entire modern interpretation of diseases of the pancreas is based upon the fact that pancreatic lesions are looked upon as more or less secondary affaits, the idea being that the primary cause outside the pancreas should be sought first in making the diagnosis. The rapid destruction of pancreatic tissue is due to the activation of trypsinogen within the gland itself, normally this is done by the enterokinase in the duodenum. The commonly accepted explanation for the activation of the trypsinogen within the pancreas is that a retrograde infection has taken place from the passage of infected bile or of duodenal contents through the ducts of Wirsung and Santorini, and further minute hemorrhages and bacterial toxins resulting from a pancreatic lymphangitis may be activating agents. Biliary tract infection constitutes by far the most frequently found 'primary' disease found in all forms of pancreatitis. In 2 of our cases the acute pancreatitis was associated with a penetrating ulcer of the duodenum the inflammation in the pancreas could well have been an extension through contiguous tissue. We have repeatedly observed that a more or less localized chronic pancreatitis due to penetrating duodenal ulcer readily affords a pathological basis for the provocation of an acute process. Inflammatory obstruction of the pancreatic duct system occurs with rupture of some of the ductules and consequent activation of trypsinogen into trypsin. Rich has shown that

metaplasia of the duct epithelium with resultant obstruction and localized dilatation of the terminal ductules is a not uncommon finding in the pancreas and advances this as a further explanation of the cause of acute pancreatitis. In the histological examination of the pancreases of 150 unselected cases removed from individuals dying from various causes other than disease of the pancreas metaplasia of the pancreatic duct epithelium was found in 28 or 18.6 per cent. Localized dilatation of the terminal ductules was also found in the 28 cases and in 17 additional cases in which the cause of the obstruction could not be discovered in the section of the pancreas available for study. The result of rupture of the acini dependent upon such obstruction will depend upon the action of the trypsin on the vessels with which it comes in contact, and will vary from resolving lesions producing scar formation to some variety of clinical acute pancreatitis.

There are no pathognomonic clinical symptoms the most important of which is pain which, with nausea vomiting and collapse will vary with the acuteness of the pancreatic disturbance and the resistance of the patient. Previous history of gall bladder disease, pain radiating from the right costal margin across the upper abdomen, tenderness following the course of the pancreas pain and tenderness to the left of the upper midline and the detection of a mass in the pancreatic area, are beacon lights when elicited. The phenomenon of general intoxication, like the secondary symptoms proceeding from the liver and the kidneys (icterus urobilinuria and hematuria) does not have a diagnostic value either large or direct but these secondary symptoms are of supreme importance in the matter of prognosis. The liberation of the ferments in the pancreatic parenchyma leads to an increase in the amount of diastase in blood and urine, the urine normally contains 10 to 20 units of diastase and the serum value remains commonly at about 170, both being greatly

increased in acute pancreatitis. The increase in diastase is frequently demonstrable within 6 to 8 hours after onset of the acute disease and diminishes or disappears after 2 or 3 days; the augmentation of the serum lipase is produced only 2 or 3 days after onset but continues for quite some time, 1 to 4 weeks, at an abnormal level. These tests constitute valuable corroborative aids when facilities for their performance are available.

Sex and age Of the 30 cases observed by us, 14 occurred in men and 16 in women. The average age of the patients was 40.7 years, 1 being in the second, 4 in the third, 7 in the fourth, 7 in the fifth, 9 in the sixth, 1 in the seventh and 1 in the eighth decades.

Previous history. Twenty-two gave a history of gall-bladder disease varying in length from 3 months to 20 years with an average duration of 3 years and 5 months; 14 gave a history of previous colics and 8 of colic immediately preceding onset of pancreatitis. Two had had cholecystostomies with removal of stones, one 6 years and one 8 months, and 3 had had drainage for acute pancreatitis, one 4 years, one 4 months, and one 8 months before present illness

Duration of symptoms referable to pancreatic involvement. These had existed in 1 for 1, in 5 for 2, in 8 for 3, in 3 for 4, in 4 for 5, in 5 for 7, in 1 for 6, in 1 for 10, in 1 for 14 and in 1 for 16 days. In 18 the symptoms developed in from 1 to 4 weeks following gall-bladder colic, in 14 the initial pain represented the only colic

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Morbid anatomy Free fluid was found in the greater peritoneal cavity in 8, being bile-tinged in 3; hemorrhagic fluid exudate was present in the lesser peritoneal cavity in 15, varying in amount from a few to 2,600 cubic centimeters. Demonstrable fat necrosis existed in 15. Recognizable disease was present in the gall bladder in 24, calculi in the gall bladder in 18 and in the common duct in 2. The gross lesions of the pancreas presented as acute edema in 9, as acute necrosis in 10, as hemorrhagic pancreatitis in 9, and as pancreatic abscess in 2, there being a wide variety of findings apparently depending upon the stages at which the patients came to operation. In the cases of acute pancreatic edema the swelling of the organ increased its size to two or three times the normal, the consistencies varying from soft to almost stony hardness. Edema, differing in degree, was noted in the omental, mesenteric, and adjacent retroperitoneal tissues, in one instance extending throughout the mesentery of the ascending and transverse colon; the edema in the tissues about the common duct in some of the cases produced marked distortion of anatomical relations.

The primary lesion in pancreatic necrosis starts in the lobule and may be limited to one part of the organ or may involve a considerable portion of it. Sloughs containing devitalized pancreatic tissue may be removed at operation or may be extruded later from the drainage tract. In the cases of hemorrhagic pancreatitis the extent of the hemorrhage depends upon the size and number of vessels

eroded, it may be limited to comparatively small areas or may be extensive as exemplified in 2 of our cases. In one the entire pancreas was embedded in a large clot, in the other the hemorrhagic extravasation involved the lesser peritoneal cavity, the retroperitoneal tissues, the mesentery of both transverse and ascending portions of the colon as far as the cecum, spreading out laterally from the latter as far as the midline internally and as far as the reflexion of the posterior parietal peritoneum externally. It seems to me that the term acute hemorrhagic pancreatitis should be discarded, if one wishes to emphasize the clinical feature of bleeding, the term acute pancreatic necrosis with hemorrhage more accurately describes the underlying pathology. Of the 2 abscesses, 1 was located in the pancreatic tissue, the mass projecting into the lesser peritoneal cavity and when opened yielded 6 ounces of pus showing a pure culture of colon bacillus, the other originating in pancreatic tissue involved as well the lesser cavity.

Operations involving pancreas—

Gauze tamponade with rubber tube (Penrose)	15
Additional operation on bile tract	
Cholecystostomy	13
Cholecystectomy	1
Drainage lesser peritoneal cavity alone	3
Drainage lesser cavity with cholecystostomy and choledochostomy	1
Evacuation of abscess with cholecystostomy	2
Operations not involving pancreas—	
Cholecystostomy alone	5
Cholecystectomy and duodenocholestomy alone	2
Cholecystoduodenostomy alone	2
Duodenojejunostomy alone	1

In our earlier experience from 1917 to 1925, an effort was made in 6 cases to introduce the drainage material directly into pancreatic tissue, in 2 instances going as far as to incise hemorrhagic areas for this purpose but 1 of these patients died, an outcome which in the light of our present day belief may be regarded as fortuitous. The drainage of the lesser peritoneal cavity alone in 3 patients was employed for the evacuation of rather large hemorrhagic exudates in one amounting to 2600 cubic centimeters. The cholecystoduodenostomy was employed in a patient who first came under observation with marked jaundice and profound sepsis, at operation no stones were found in gall bladder pancreatic enlargement and fat necrosis were present

and the gastrohepatic omentum covering common duct was greatly thickened and edematous. A cholecystostomy alone was done and some weeks later, after subsidence of the jaundice and sepsis, the abdomen was reopened, a single non faceted stone being removed from the terminal portion of the common duct. Following this the patient remained symptom free for 8 months when she developed an acute pancreatitis, the pancreatic mass being palpable through a thick abdominal wall. At operation the organ presented an acute swelling being three to four times its normal size while the parapancreatic tissues showed a greenish hued edema. After the gall bladder and duodenum were freed of adhesions an anastomosis was made between them and the patient recovered.

The duodenojejunostomy was done in a patient 22 years of age who came to us with a history of repeated colics, the last or present one of which was severe and accompanied by fever and jaundice. Operation revealed a huge duodenum due to obstruction at the duodenojejunal junction, the presence of a perforating duodenal ulcer into the head of the pancreas, pancreatic enlargement, and fat necrosis. The duodenum was opened through the transverse mesocolon and cleansed of an accumulation of seeds, beans, corn, and 3 one cent pieces, after which it was anastomosed with the jejunum followed by recovery of patient. The obstruction at the duodenojejunal junction was evidently congenital in origin, the mother stating that the three coins had been swallowed at the age of 6 years.

Mortality. There were in the series, 9 deaths a mortality of 30 per cent. Five occurred in the acute pancreatic necrosis and 4 in the acute hemorrhagic pancreatic groups with none in the acute pancreatic edema and pancreatic abscess groups. Three of the acute necrosis cases had pancreatic drainage alone, and patients died on the eighth, thirtieth, eighth and one hundred and eleventh post operative days, autopsy in the 2 latter showed extensive retroperitoneal necrosis and suppuration. Of the 2 remaining acute necrosis cases 1 patient had pancreatic drainage and cholecystostomy and died on the third day and 1 had cholecystectomy and chole-

docholestomy alone, the diagnosis of the pancreatic lesion at time of operation being edema, and death occurred on the ninth postoperative day, autopsy showing extensive pancreatic necrosis. Of the acute hemorrhagic pancreatitis group, 1 had cholecystostomy with evacuation of hemorrhagic fluid from and drainage of the lesser peritoneal cavity, death following 4 hours after operation. Two, 1 with cholecystostomy alone and 1 with cholecystectomy and choledochostomy, presented marked enlargement of the pancreas at time of operation thought by me to be edema, 1 died on the sixth and 1 on the ninth day after operation, the autopsy showing hemorrhagic pancreatitis in both. The fourth patient in this group presented an extensive hemorrhagic pancreatitis, the lesser peritoneal cavity being distended with hemorrhagic exudate and blood clots and the gall bladder and common duct buried from view in dense adhesions. Evacuation and drainage of the lesser cavity were done without drainage of the biliary tract. Convalescence was stormy but finally reached a stage at which patient was able to be up, when on the forty-eighth postoperative day there was a recurrence of pain, free hemorrhage from the drainage tract, hematemesis, and melena, with death on the fifty-fourth postoperative day.

Acute pancreatitis until within recent years has been universally regarded as an indication for immediate operation, the accepted indications being to relieve tension, to stop hemorrhage, to prevent leakage, and to afford drainage. In the belief that operative procedure will neither lessen nor control the formation of trypsin nor prevent its further destructive action in the pancreas, there are many at the present time who contend that operation is best deferred until the acute pancreatic symptoms subside. The claim is made that by so doing opportunity is given for localization of the pancreatic disturbance while early operation tends to break down protective barriers and to increase the dangers of necrosis and hemorrhage from trauma to the diseased organ. While in the series herewith reported there has been no delay in operating upon patients after admission to the hospital other than that occasioned by res-

toration of fluid balance and rehabilitation by transfusions, an analysis of it finds much to support the advocates of delayed operation. We have not hesitated to employ glucose solution intravenously although theoretically contra-indicated by the elevation of the blood sugar thus increasing the flow of pancreatic enzymes. The rapid depletion of liver glycogen dependent upon the absence of food and the presence of vomiting, together with the frequency of liver damage shown at post-mortem, would indicate its use, the objection to which can be obviated by the simultaneous administration of insulin. There were no deaths in the 2 cases of abscess and 9 of acute edema, but it is to be noted that in 3 cases classified at operation as acute edema in which the surgical procedure was limited to the correction of the associated pathological condition in the bile tract, death followed on the sixth, eighth, and ninth postoperative days, autopsy showing in each acute pancreatic necrosis. The interpretation of the pancreatic pathology may have been erroneous; the operative trauma may have activated the pancreatic disease or what is more probably correct, the pancreatic edema was but the primary state of the necrosis. It has been stated that edema of the pancreas does not necessarily make the transition to necrosis and hemorrhage, an observation borne out by the 9 recoveries in this group; it has been further stated that edema may very well be looked upon as an independent malady with good prognosis for the most part and with indications for operation decidedly different from those of necrosis, hemorrhage, and abscess. That the indicated operative procedures are different most surgeons will agree, but there will be found wide dissent upon the hypothesis that edema is a separate entity. The performance of the operations with relation to the onset of symptoms relating to the pancreas was as follows: 6 on the second day with 4 recoveries and 2 deaths; 8 on the third day with 3 recoveries and 5 deaths; 3 on the fourth day with 2 recoveries and 1 death; 4 on the fifth day with 3 recoveries and 1 death; in the remaining 9 done from the sixth to the sixteenth day there were no deaths. The entire mortality followed operations done from the

second to the fifth day, 7 of the 9 ensuing from those done on the second and third day, while no fatality was noted in operations after the sixth day. These results apparently indicate the comparative safety of the delayed operation, but I cannot escape the conviction that some of the recoveries would have been converted into fatalities by delay. The operative record of one such recovery will indicate the pathological basis for such belief.

When the peritoneum is opened bile tinged fluid escapes. Visible omental and mesenteric fat shows the presence of multiple areas of fat necrosis. Gall bladder tightly distended and covered by adherent omentum and colon. Gastrohepatic omentum shows the presence of gangrenous areas and upon perforation a quantity of hemorrhagic fluid escapes from the lesser cavity. Penrose drain is placed down to and above the head of the pancreas. Gastrocolic omentum is opened and Penrose drain placed along lower border of pancreas. Examination of the mesocolon at the hepatic flexure shows that the pancreatic fluids have caused a rather extensive retroperitoneal necrosis; this spreads laterally from the mesocolon reaching the lateral abdominal wall to the outer side and extending well toward the vertebral column on the inner side. Penrose drains are placed in the slit mesocolon and in the gutter between the ascending colon and the abdominal wall. Gall bladder is opened, stones evacuated and drainage made with rubber tube all drains being brought out middle third of incision.

The period of time elapsing between operation and death was 4 hours in 1, 3 days in 1, 6 days in 1, 8 days in 1, 9 days in 2, 38 days in 1, 54 in 1 and 111 in 1. In the 3 patients living longer than 9 days pancreaticasthenia was noted characterized by weakness, nausea and anorexia, death occurring in one with recurrence of bleeding from the drainage and gastro intestinal tracts indicating a further diffusion of trypsin, and in the 2 remaining from exhaustion, autopsy showing extensive pancreatic and retroperitoneal destruction. With the exception of the 1 patient dying of shock all died of tryptic digestion of the pancreas. As this process is a chemical and not an inflammatory one the proponents of the delayed operation believe that the use of gauze tamponade and drainage does not favorably influence the reparative process in pancreas. In 8 of our 9 cases this assumption is borne out. Three patients suffered recurrent attacks of acute pancreatitis at 4 months, 8 months

and 4 years, respectively, in all 3 of which gall stones were removed and the gall bladder drained at the first operation. Assuming the correctness of the belief that biliary tract disease is the predominant etiological factor, this experience would indicate the advisability of cholecystectomy in patients recovering from attacks of acute pancreatitis as a prophylactic measure against recurrence. Since such a procedure can rarely be safely done in the presence of an acute attack, it becomes an added argument for the deferred operation. The observation of areas of fat necrosis in interval operations upon patients giving histories of severe biliary tract disease is not such an uncommon one and affords conclusive proof of spontaneous recovery from acute pancreatitis.

The difficulty in making a correct pre-operative diagnosis adds no little to one's perplexity in deciding for or against deferred operation and in evaluating the results of the proponents of the latter. The gravity of the lesion is such that deaths will of necessity follow both plans of treatment. If one elects the deferred plan, unless he is willing to make exploratory operations in doubtful cases or is possessed of unusual diagnostic acumen the mortality will be but increased by high obstructions, ulcer perforations, and gangrenous cholecystitis. The correct pre-operative diagnosis was made in but 12, or 40 per cent of our series, the error in 14, or 47 per cent lay in thinking the lesion to be acute cholecystitis. It would be of interest to know in how many instances of acute surgical conditions of the abdomen a diagnosis of acute pancreatitis had been made and at operation pancreatitis was not found, unfortunately no such data are at hand.

CONCLUSIONS

1. Acute pancreatitis comprises 3 clinical groups which are but different stages of the same process, acute pancreatic edema, acute pancreatic necrosis, and pancreatic abscess.
2. The deferred operation offers definite advantages in selected cases, a correct diagnosis being essential to its employment.
3. Patients presenting jaundice and with palpable masses due to distention of the lesser

peritoneal cavity, with manifest enlargement of the gall bladder, or with evidence of spreading peritonitis, are best treated by early operation.

4 Operative attack on the pancreatic tissue is not justified; drains, gauze, or Penrose drain should be placed down to, but not in, pancreatic tissue

5. The utmost gentleness should be exercised in handling the pancreas and para-

pancreatic tissue; pressure from retractors is to be studiously avoided.

6. Bile-tract disease, the predominant etiological factor in the light of present knowledge, should receive such surgical attention as time of operation and the local pathological condition permits. If early operation is done, drainage at least should be instituted. In delayed operations a complete toilet of the bile tract is desirable

THE PRESENT STATUS OF THE OPERATIVE TREATMENT OF FRACTURES

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THE pioneers of the operative treatment of acute fractures as practiced today are Lambotte of Antwerp and Sir Arbuthnot Lane of London. To these courageous surgeons, who have made such substantial contributions to the surgical armamentarium and technique, we owe a great debt of gratitude

A recent visitor to our clinic from Australia, who had spent 18 months visiting the various clinics of Great Britain, Europe, and the United States, asserted he was very much confused and in great doubt as to what procedures or practices were best because of the many and divergent methods employed, as well as the claims made for each of them

The introduction of x-ray films as evidence in Court, with interpretations by the laity, now constitutes a legal threat to force a more accurate anatomical replacement of fractured bones. The patient is frequently under the impression that the "Doctor has set the fracture" only to realize, months or years later, that it had not been reduced. It is, therefore, advisable to show the x-ray films to the patient and to explain the conditions, indications, etc., if operative procedure is necessary. When the patient is confronted with the fact

that he is likely to go through life with a limp, loss of function, or similar disability, he will readily consent to submit to a reasonable and safe recommendation. A surgeon would not permit a fracture to remain uncorrected either in himself or members of his family. Why should not the same consideration be extended to his patients?

For the past 30 years severe criticism has been leveled at those who have used steel bone plates, screws, nails, etc. Many of the leading critics in personal interviews have admitted to me that they never had had any experience whatsoever with steel plates, screws, or nails in the treatment of acute fractures and that their opinion was based entirely on the poor end-results which they have seen in cases in which the operation was imperfectly or poorly done. In the medical schools certain of the professors, when discussing the operative treatment of fractures, stated, "We merely mention steel plates, screws, and nails in order to condemn or decry their use."

In July, 1929, the author attended a meeting of British and American bone and joint surgeons in London. One morning of the program was devoted to the discussion of the treatment of intracapsular fractures of the hip joint. Royal Whitman made a valiant

stand for the anatomical reduction and physiological treatment by the abduction method, plaster, and rest. A group of 14 cases was presented in which the Thomas splint had been used and was advocated as the method of treatment with traction and immobilization. There was a questionable reduction in all of the cases and the end functional results were anything but satisfactory. There was no criticism made, however, of the use of the Thomas splint. Philip Wilson made a brief preliminary verbal report of 23 cases in which patients had been treated by the operative method by Smith Petersen. Mere mention of the operative treatment was severely condemned notwithstanding the fact that those making the condemnation had little or no knowledge of the operative technique. Much credit is due Smith Petersen for his contribution to this subject. The technique now has been refined so that with the assistance of the x-ray as a guide, only an incision over the trochanter is necessary to insert steel fixation in the form of nails or screws. The results reported by Smith Petersen, Watson Jones, Sven Johansson, Brewster, Moore and Cubbins and his group, are very encouraging and while it is too early to evaluate the end functional results there is ample justification for this technique at the present time in the hands of those trained and competent.

The high mortality and large percentage of non unions as a result of the abduction method make it imperative that something be done to shorten the convalescent period and improve end functional results; hence it is obvious that such operations should be done only by those exceptionally well trained and equipped.

It is certainly desirable to make these patients ambulatory in from 5 days to 2 weeks as against the patient remaining in a "coffin of plaster of paris" for a period of 3 to 5 months.

Since the World War there has been "mass production" of bone and joint specialists, many of whom lack general surgical training. A surgeon who requires 3 hours to do an operation that should be done in 45 minutes should not attempt it.

VANADIUM STEEL BONE PLATES AND SCREWS

In 1909, following Sir Arbuthnot Lane's advocacy in America of the use of steel plates and screws, the author adopted this technique when operation was indicated and in 1911 he reported 72 operative cases. It was soon found that the screws were too soft and the plates too hard, with the result that the screws pulled out and the plates broke. This led to the redesigning and patenting of vanadium plates and screws in 1911, with the idea of securing plates having maximum strength with a minimum amount of foreign material. If the plates and screws are made according to specifications they will not break, but quantity production during the World War resulted in the market being flooded with plates and screws which had never been inspected either from a physical or metallurgical standpoint. The havoc produced by the breaking of these plates and by the pulling out of these screws, brought a storm of protest to the American College of Surgeons from surgeons throughout the country. The author presented his patents to the College and the Fracture Committee took up the matter with the United States Bureau of Standards. After a thorough joint investigation, they adopted and approved as standard the same designs of the plates and screws as advocated in 1909, as well as the metallurgical specifications as set forth in the patent.

The undesirability of beef bone, ivory, gold, silver, and metals containing copper, chromium and nickel after the great claims made for them, is a matter of common knowledge.

"Cat and dog" experimenters have strenuously objected to the use of steel in the fixation of fractures quite unmindful of the fact that as a result of the high explosives used in the World War, millions of individuals carry iron and steel about in their bodies without localizing or irritating symptoms. There are also many thousands of individuals who have been operated upon during the past 30 to 40 years in whom the plates have remained *in situ* without deleterious effects. We take strong exception to the teaching that plates and screws should be removed unless there are specific indications for their removal.

If the proper technique is followed in applying plates, 95 per cent will remain permanently in simple fractures without any necessity for removal, whereas 48 per cent *are* removed in compound fractures. The results of animal experiments in which steel plates and screws have been used and condemned, are not of great value because of the difficulty in carrying out the meticulous, non-touch technique so necessary.

Non-ferrous substances are being advocated but they are not comparable to the steel alloys in their physical characteristics. The objection to them is, they are too bulky and hard and, therefore, liable to fracture. The objection to stainless steel is that it contains chromium and is rather difficult to temper. Ductility, and not extreme hardness, is the quality most desired.

Electrolysis is not a factor when plates and screws are made of the same steel. In cases in which plates have been removed, the staining of periosteum has been noted. This staining is due to an oxidation of the iron, ferric oxide, and is not in the least objectionable as it is non-irritating as proved by the fact that many thousands of patients operated upon in whom steel plates and screws have remained *in situ* from 5 to 28 years, are entirely unconscious of their presence, as there never have been any objective or subjective symptoms.

It is only reasonable to assume that at some time in the future an alloy may be produced which will have greater physical properties than vanadium steel, but it is doubtful if such an alloy will be of a non-ferrous nature.

CARREL TECHNIQUE

Carrel technique with sodium hypochlorite—0.5 per cent sodium hypochlorite and 0.9 and 0.10 per cent sodium chloride—is a prophylactic against infection as well as of great value in the treatment of suppuration.

The objection to Dakin's solution as made from bleaching lime is that it is unstable and caustic, necessitating the making and testing of a new supply every few days. For the past 18 years we have used to the exclusion of all other antiseptics and chlorines, a concentrated, electrolytically prepared sodium hypo-

chlorite of 4.05 per cent and sodium chloride 3.25 per cent, bearing the trade name "*Hypochlorite*," which has the approval of the Council of Pharmacy of the American Medical Association. Its great advantage is that it is stable and of low alkalinity and can readily be made available for use by the dilution of 1 part of the concentrate to $6\frac{1}{2}$ or 7 parts of water. It is an ideal physiological antiseptic as it destroys nitrogenous bacteria and necrotic tissue by the process of oxidation without inhibiting or in any way destroying viable cells or tissues, and I believe it would have met with the full approval of Lister.

Within a few years the antiseptics used today in the treatment of wounds—phenols, synthetic coal tar compounds, bichloride of mercury, potassium permanganate, peroxide of hydrogen, etc.—will be obsolete and many of the beautifully colored and attractively bottled proprietary antiseptics, whose chief value is confined to the test tube (not unlike iodoform gauze whose greatest virtue was its color and stench), will fall into disuse. It is interesting to note that of the hundreds of antiseptics which have been advocated during the past 50 years, very few have withstood the test of time—a rather sad, but true, commentary.

Those who decry the use of the Carrel technique, stating the same end-results can be secured with saline or other antiseptics, have little fundamental understanding or experience either with the method or of the chemical action of aqueous sodium hypochlorite. There is little or no opportunity for infection to take place in a compound fracture if an early débridement is done, and the Carrel technique is instituted at the time of operation.

The surgeon should be held responsible for postoperative infection if he fails to utilize the equivalent of a specific in the treatment of compound fractures—the Carrel technique—and he is open to fair and just criticism in view of the end-results which were secured by its use in the World War as well as in those clinics where it is used thoroughly and intelligently today.

The use of vaseline gauze packs or maggots has no place in the scientific treatment of compound fractures or their postoperative

complications, despite the enthusiastic advocacy of those measures. We are advised by the etymologists that the active principle of the maggot is an enzyme and to this property is ascribed the justification for the use of maggots in surgery.

We should not be hypersensitive to constructive criticism. There has been more or less hysteria associated with many of our very questionable practices. Criticism of other cults should be restrained until such time as we have "cleaned house."

COMPOUND FRACTURES

It has been the general opinion that steel plates and screws should never be used in the treatment of compound fractures. This opinion is based entirely upon theory and not on actual experience.

In 1933, George V. Foster, the author's associate, reported 304 consecutive compound fractures of the long bones treated by débridement, Carrel technique, open reduction, and plating when indicated. In this series over a 15 year period (1917 to 1932) 129 compound fractures were plated, there were no frank infections, and 1 amputation at the end of 3 weeks was necessary on account of the great loss of substance, bone and soft parts. There were 2 fatalities—one 4 weeks and the other 6 months after secondary operation. In the plated series the incidence of non union was 1.5 per cent while in the unplated cases, it was 40 per cent. The difference in the percentage ratio was most likely due to the extensive comminution found in the unplated series.

In our clinic we employ the following principles in all compound fractures regardless of their severity and have had but one frank infection since 1917.

1. A thorough cleansing of the wound and surrounding skin.
2. A conservative but thorough, debridement.
3. Reduction of the fracture—manipulation with or without internal fixation or skeletal traction.
4. The Carrel technique instituted immediately following operation as a prophylactic measure.

5. Immobilization of fracture, preferably with molded plaster of Paris, involving the proximal and distal joints.

6. Unsupported weight bearing not permitted until a strong bony union has taken place.

7. Plastic reconstruction if indicated, after cicatrization has been completed.

8. Physiotherapy—Morton Smart method of electrically graduated muscle contraction to restore muscle tone, active exercises.

INDIRECT OPERATIVE TECHNIQUE (Skeletal Traction)

Skeletal traction with ice tongs, Steinmann pin, Kirschner wire, etc., has been used in many clinics to the exclusion of other procedures. This is due either to the lack of knowledge of the non-operative technique and timidity or to the lack of confidence and inexperience in the direct operative attack. There is no question but that skeletal traction has an important place in the treatment of fractures, especially in extensive comminuted fractures. The percentage of infection (7 to 10 per cent) in 2 of the leading hospitals in the same city in this country is sufficient evidence that it is not without its dangers and complications. At best, skeletal traction is a 'bastard' form of the operative treatment. It must be used with discretion and only in those cases in which it is indicated. The 'robots' which have recently made their appearance, are of value in selected cases. It is an error of judgment however to expect to correct all displacements with this one procedure. A simple fracture is always more desirable than an incomplete compound fracture such as is produced in skeletal traction.

The literature abounds in reports of small groups of cases in which patients were treated by skeletal traction but contains very few reports of unsuccessful cases in which the complications, dangers, failures, etc., have been evaluated. In one case of skeletal traction of the femur in which ice tongs were employed we encountered a serious secondary hemorrhage. Like the operative attack, skeletal traction is not without its dangers and it will eventually find its proper place in the treatment of fractures but not to the

extent that it is being used today in many clinics to the exclusion of every other method

DIRECT OPERATIVE TECHNIQUE

The time-consuming, elaborate pre-operative preparation of the operative field, is unnecessary. Thorough cleansing of the skin with soap, water, and alcohol the evening of the day preceding operation, is sufficient. The operative field is prepared with either a 5 per cent picric acid or a 3 per cent tincture of iodine solution, is carefully draped, and the towels affixed. *At no time* are the fingers, instruments, gauze, catgut, etc., permitted to contact the skin. In other words, the non-contact technique of Lane is scrupulously carried out

TECHNIQUE OF OPERATION

Simple fracture of the femur. An external incision is made with a sharp scalpel through the skin and fat, after which this instrument is discarded. A tissue forcep and clean scalpel are used to undermine the skin and fat to permit of an ample exposure. Turkish towels are then carefully affixed to the cut skin edges with either Michel clips, Lane or Moynihan towel clamps, and the ends of the towels are fastened with Backhaus towel clips. The skin should not be exposed to the slightest degree as it is considered a source of contamination. The fascia lata is then incised and reflected. The vastus externus is incised and the cruræus muscle reflected and the fractured ends exposed. The proximal and distal fragments are not eviscerated into the wound or stripped free of their periosteal and muscular attachment any more than is absolutely necessary. A Lane or Lambotte clamp grasps the proximal or distal fragment and any intervening periosteum, muscle, or fascia is removed by curettage. The fracture is then reduced within the wound by traction and manipulation.

Immediately following the reduction, which is usually of a hair-line nature, a Lambotte or Lowman clamp is affixed to the site of fracture and a 6-screw plate is clamped to the external surface of the femur. The overall measurement, including the plate, is taken by a caliper in order to determine the exact

length of the screw necessary to engage the proximal and distal cortex and, at the same time, not to extend beyond the distal cortex. The bone is drilled through the proximal and distal cortex and a transfixion screw inserted. After a transfixion screw has been applied to both fragments, screws involving only the proximal cortex can be inserted. The drill can be either a hand or a motor-driven one, preferably of the twist type.

Great care should be taken to remove any periosteum at the site of the drill hole. Failure to do so causes the screw to twist about the periosteum and interfere with the proper cutting or tapping of the bone. After all screws have been inserted, the bone clamps are removed and all bleeding points carefully ligated as an absolutely dry wound is desired. The cruræus and vastus externus muscles are sutured with a figure-of-eight double No. 1 catgut, the fascia lata is closed with a double continuous chromic No. 00 catgut. Wherever possible, such as in the tibia, the periosteum should be gently reflected and sutured over the bone plate and screws with figure-of-eight catgut sutures. The skin is closed with Michel clips or with a vertical mattress silk suture and the fracture is splinted in a Thomas splint with Pierson flexion attachment; in fractures of the lower leg and forearm, molded plaster splints are used and are worn until firm bony union has occurred. Drainage is never used.

Recently we have had 2 non-unions due to too early weight-bearing after the patient's discharge from the hospital at which time bony union had been present.

If the technique, as described, is carefully followed, wound infection is no greater than in any other elective type of operation such as goiter, hernia, or chronic appendicitis. Bone plates and screws are not the source of infection as has been so frequently stated. Should infection occur, it is usually due to faulty technique or lack of operative skill on the part of the surgeon. If positive evidence of infection arises, with elevation of temperature, redness, swelling, or other symptoms, the wound should be thoroughly opened at once, all sutures removed, the bone plate exposed but allowed to remain *in situ*, and the Carrel technique instituted.

Those who have decried the use of steel bone plates have had little or no experience in their use. It is rather unfortunate that this criticism of those who have successfully used steel plates in the operative treatment of fractures, has retarded, at least 25 years the general scientific acceptance of the direct operative treatment here indicated.

BONE GRAFTING—PSEUDARTHROSIS

In a small percentage of cases non union will result whether steel plates and screws are used, or whether no operation has been done. Sufficient time should elapse before grafting is considered. This operation is not indicated in the treatment of acute fractures or for delayed union but for pseudarthrosis. Absolute fixation of the bone graft to the host, with 2 or more vanadium tap screws has greatly improved the immobilization of the bone graft and this is a very important and desirable factor. Fixation of fractures without motion is imperative until such time as bony union has occurred. There is little or no divergence of opinion as to the indications or technique where bone-grafting is indicated. Massive grafts are preferable. The step cut procedure is usually practiced with transfixion screws in the arm and forearm. The inlay in the tibia is the operation of choice and either an inlay or an onlay in fractures of the humerus and femur. In several cases, 2 grafting operations were necessary and in one case, 3 operations were done. In all cases bony union was eventually secured.

FACTORS CAUSING INFECTION

1 Too early operation. Simple fractures should not be operated upon until the swelling and blebs have subsided and the temperature becomes normal, which is usually, 10 to 14 days. The trauma caused by operation in addition to the already existing trauma, tends to produce necrosis of the tissues with resultant sloughing and infection. If operation is deferred 10 to 12 days it is usually bloodless and the postoperative reaction nil. We feel that this delay is of great importance and a large factor in combating infection and necrosis of tissue, obviously, compound fractures should be operated upon immediately.

2 Failure to carry out the non touch aseptic technique.

3 Excessive trauma caused by the rough handling of tissues and failure to carry out sharp dissection.

4 Lack of proper surgical armamentarium to facilitate operation. Most operations of this character should be completed in 35 to 45 minutes. The surgeon who procrastinates or prolongs the operation to 2 or 3 hours should either improve his technique or not attempt the operation.

5 Lack of an organized surgical team—that is, assistants and nurses. Failure to plan in advance and practice the meticulous technique, thereby causing many errors in the procedure and subsequent wound contamination. This failure of organization and team work is frequently the alibi of those who find it difficult to adjust themselves to such an exacting technique. With practice, the non touch technique soon becomes "almost automatic."

SUMMARY AND CONCLUSIONS

Frequently we have been accused of being guilty of operating on all fractures regardless of their nature. Nothing could be further from the truth. Those who have taken the time to inspect our records and x-ray films and note the end functional results in the patients operated upon, have been convinced not only of the necessity for the operation but are cognizant of the excellent end functional results secured. There is no legitimate excuse for neglect in the reduction of fractures any more than there is a legitimate excuse for anyone starving to death in a time of plenty. The vast majority of fractures can be satisfactorily reduced.

1 By the closed method, that is, by manipulation, traction and similar procedures.

2 By direct or indirect operative treatment, when indicated, and in clinics where conditions make such practice a safe procedure.

One of the large bone and joint clinics reports 33 per cent of the patients admitted have malunion or other complications following fractures. The same ratio exists in many

other clinics This is certainly not very complimentary to the initial treatment rendered and is evidence of the fact that much remains to be done to improve the methods of treatment and end-results.

The government of Australia and The Seamen's Hospital Society of Greenwich, England, have organized and instituted a study of this subject and are making constructive suggestions to correct conditions as they now exist If the medical profession fails to meet its responsibilities, the public undoubtedly will take the matter into its own hands and attempt to improve conditions through governmental or other agencies Such a situation would be a deplorable one, indeed, and the general practitioner and surgeon cannot evade this challenge The co-operation of the Council of Industrial Health recently created by the American Medical Association, together with the American College of Surgeons, can do much to improve present unsatisfactory conditions.

During the past 28 years the author and his associates have carried out the practices and

principles as herein outlined in more than 8,000 compound fractures and in cases in which osteosynthesis has been done. At first thought this large series would give one the impression of unnecessary operations However, when it is taken into consideration that a great majority of those injuries originated in an industrial army employing some 150,000 men engaged in the manufacture and fabrication of iron and steel, and the transportation of 200,000,000 tons annually of raw and finished materials, it is evident that despite all safety precautions, the handling of such great tonnage is certain to cause serious trauma.

The principles and technique which we have routinely practiced over these many years with such satisfactory end functional results, both from a humane and economic standpoint to the employee, employer, and surgeons, will be continued until such time as better methods are evolved which will improve the end functional results over the shortest period of time and with the greatest safety and comfort to the patient.

SOME PHYSIOLOGICAL AND PATHOLOGICAL OBSERVATIONS ON THE URINARY TRACT DURING PREGNANCY

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THIS article deals with our continued studies of the urinary tract during pregnancy, the first portion of the presentation consisting of a summarized review of the physiological changes which we have previously published. Their reconsideration now is of value as the interpretation of the pathological processes which we will here consider are largely dependent upon these changes. We shall also report our findings in regard to the frequency of organisms found in the urine of normal pregnant women, which obviously have a very direct relationship to the incidence of inflammatory lesions arising during gestation. These inflammatory lesions and their treatment will also be considered.

Due to the pioneer work of Pierre Rayer and Cruveilhier, in the middle of the 19th century, on the question of dilatation changes in the urinary tract during pregnancy, great interest was focused on this heretofore undescribed observation. In the early days these findings were made at the autopsy table, later at operation, and not until the development of the cystoscope by Nitze was it realized that these dilatation changes were not of infrequent occurrence. With the introduction of intravenous urography made possible by the original work of Rowntree and his co-workers in 1923 and further developed by Swick and Binz in 1929, an increasing amount of investigative work has been done. Among the many investigators working on the urinary tract changes Duncan and Seng Lee and Mengert, P. Schumacher, Hofbauer, Dugald Baird, Kretschmer, Heaney and Ockuly should be mentioned. In our paper on the "Physiological Changes Occurring in the Urinary Tract During Pregnancy," we dis-

cussed in some detail the anatomical and histological changes observed, and also considered the causes of dilatation of the upper urinary tract. A summary of the more important findings will be referred to here.

From the intravenous urographic study of 27 normal pregnant women throughout the succeeding months of gestation and the puerperium, certain outstanding facts were brought out. We found the most constant change in the urinary system was a dilatation of the pelvis and calyces of one or both kidneys, a dilatation, tortuosity and kinking of one or both ureters, and a lateral displacement of these structures. Every patient showed some deviation from the normal, ranging from a slight dilatation to a marked degree of hydronephrosis and hydroureter. The right kidney and ureter were more affected than the left. The dilatation of the ureter always began at the pelvic brim, and in not one of the patients studied was there found a definite and significant dilatation of the pelvic portion of this structure. With the advance of pregnancy the dilatation of the upper urinary tract gradually increased, and we were unable to observe that it reached its maximum degree some weeks antepartum and then remained stationary until delivery. We feel that it is a gradual and progressive dilatation. Following delivery, there is a return of the urinary system to normal. We found that of 26 patients examined after delivery, 18 showed a return to normal in 28 days. However, 1 patient required 56 days. It is a well known fact that the presence of frank infection greatly retards the normal involution process. Figure 12 shows beginning dilatation of the ureters and pelvis of both kidneys at the fifteenth week of pregnancy. The 7 illustrations following are succeeding examinations of the same patient, beginning at the eighteenth week of pregnancy and continuing

From the departments of Gynecology, Obstetrics and Radiology of the University of Maryland.
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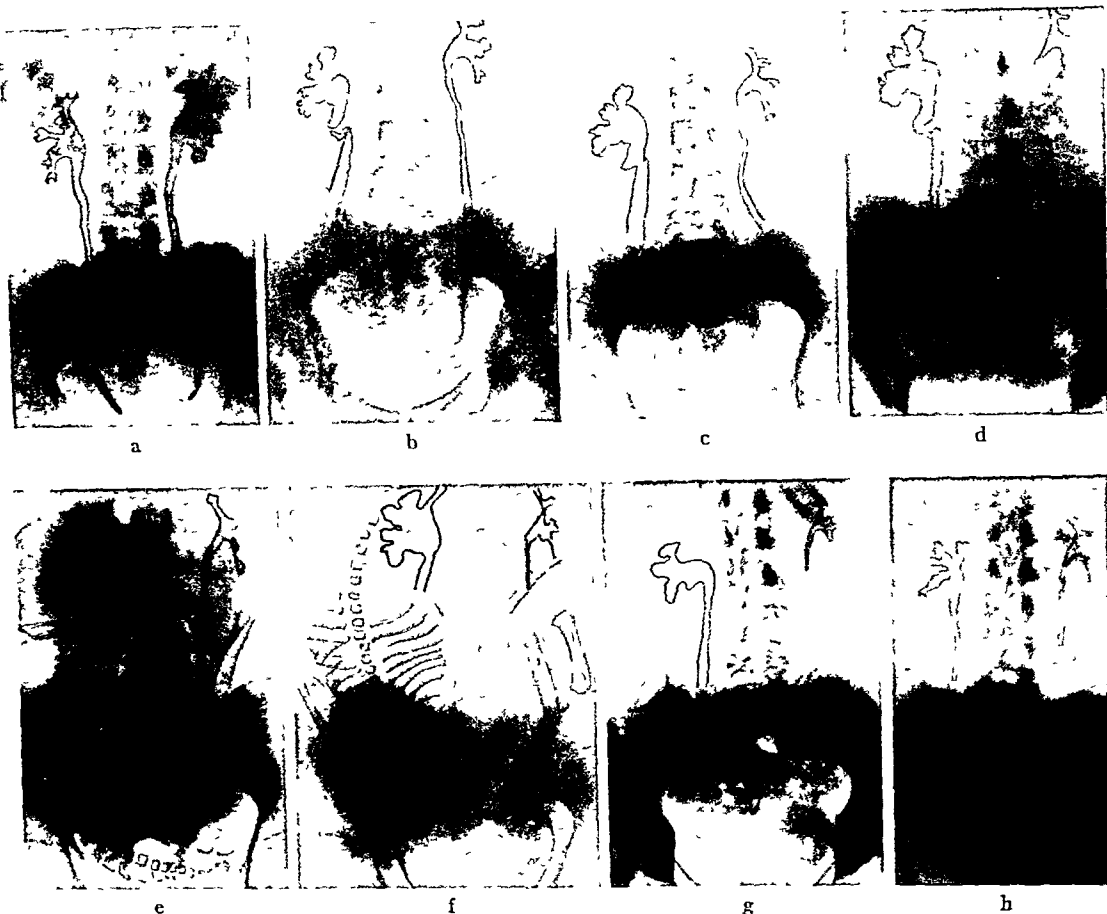


Fig 1. a, A P., 15 weeks Beginning dilatation of both pelves and lumbar ureters. Also slight dilatation of the right pelvic ureter. Fetus seen in the pelvis. b, M L., 18 weeks Dilated pelvis and calyces of right kidney. Dilated and kinked right ureter. Dilatation beginning at brim of pelvis. Slight dilatation of left lumbar ureter. c, M L., 22 weeks Increasing dilatation of right pelvis, calyces, and lumbar ureter. Very slight dilatation of left lumbar ureter with beginning outward displacement. Fetus well visualized in pelvis. d, M. L., 26 weeks No increase of dilatation of right pelvis, calyces and ureter since last examination. Fetus visualized, breech presentation, spine to the left. e, M L., 34 weeks. Increasing dilatation of right

pelvis, calyces and ureter. Left kidney and ureter appear normal. Fetus is visualized, breech presentation, spine to the right. f, M. L., 39 weeks. No increase of dilatation of right pelvis, calyces or ureter since last examination. Left kidney and ureter appear normal. Position of fetus—vertex presentation, spine to the right. g, M L., 1 week after delivery. Pelvis and calyces of the right kidney have nearly returned to normal, but there is still a moderate dilatation of the right ureter. h, M L., 6 weeks after delivery. The right pelvis, calyces, and ureter are now normal. Urograms have been outlined for better reproduction. (Courtesy of Am. J Obst. & Gynec, 1935, 30:625)

until the sixth week postpartum (Fig 1b, c, d, e, f, g, h). It was observed that the dilatation of the urinary tract occurred later in the primiparae than in the multiparae, whereas the dilatations were more marked in the former than in the latter group. We do not feel that the position of the fetus has any bearing upon the dilatation changes observed, owing to its frequent change of position. At

one x-ray examination, the fetus changed from a vertex to a breech presentation during the 15-minute interval between exposures.

An anatomical and histological study was then conducted on the urinary tracts of 13 parturient women, all but 2 dying at term. In only 1 patient was there an infectious process found in the urinary tract, multiple punctate abscesses being found in the cortex of the

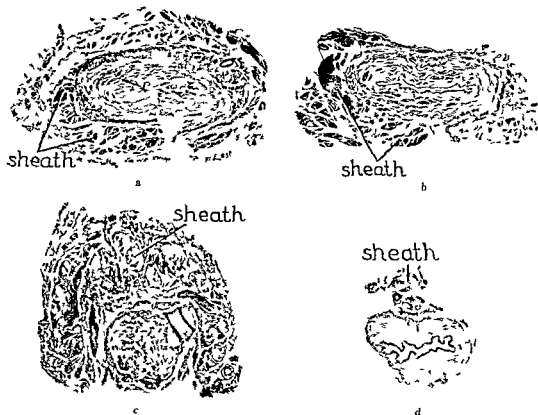


Fig 2 (Legend on opposite page)

kidney. However, the bladder and ureters showed no evidence of inflammation.

In every case but one, some dilatation of the ureter was found, the right side being constantly more dilated than the left. It is frequently stated that the dilated, tortuous, and kinked ureters occurring with pregnancy are longer than those not so associated. However, this has not been our observation. The longest ureter was found to measure 30 centimeters and the shortest measured 17 centimeters. The average length was from 24 to 28 centimeters. The sacculated dilatations of the upper ureter give one the impression that there is elongation of the tract, which is not borne out by actual measurement. However, it will be noted later that lengthening of the ureter may occur when there is a marked infection present.

The gross appearance of the ureters associated with pregnancy had many points in

common. They all showed some degree of dilatation, usually on the right side, which always began above the brim of the pelvis. The lower end of the pelvic ureter was quite firm and rigid, whereas the abdominal spindle was always flaccid and ribbon like, with definite loss of tone. No evidence of stricture formation was made out either grossly or microscopically.

The ureter was sectioned at different levels, and preparations of the bladder, trigone, and urethra were also made. Microscopical study of these tissues showed varying degrees of hypertrophy of the musculature, edema, and increased vascularity. These changes seemed to go hand in hand with similar physiological changes occurring in the generative tract during pregnancy.

The most striking change seen in the urinary tract is the marked hypertrophy of the external longitudinal sheath of muscle bun

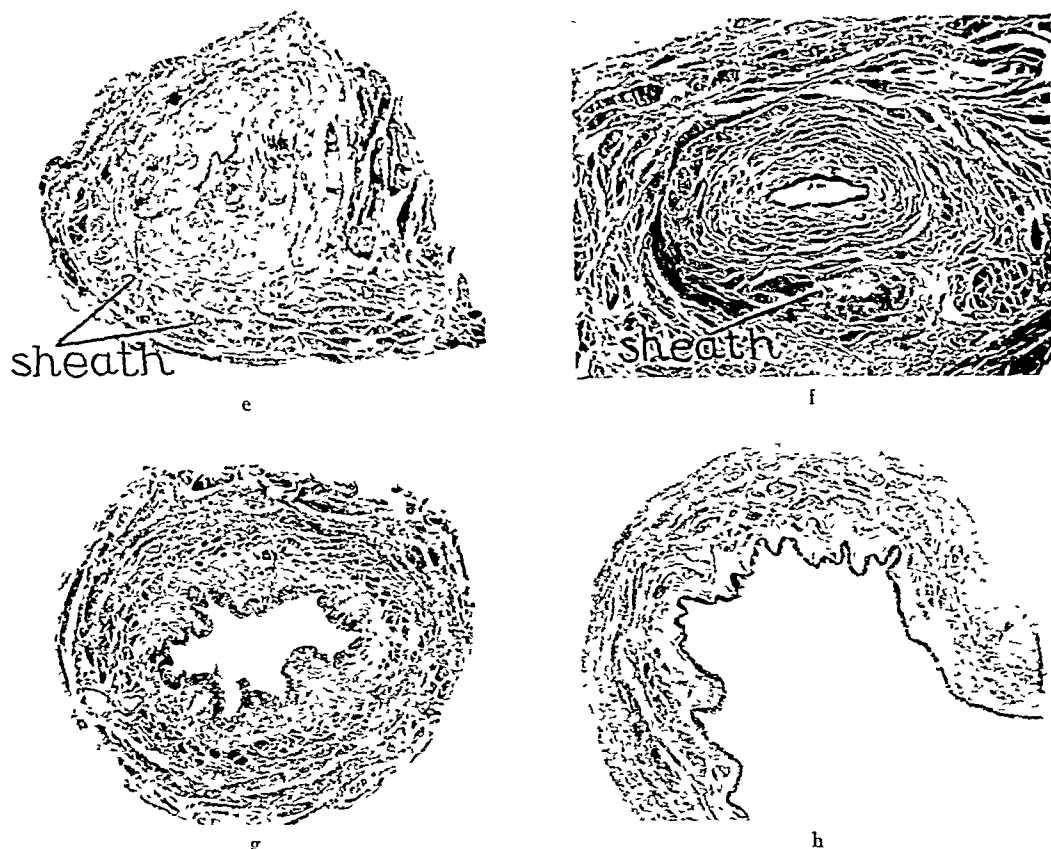


Fig 2 a, Pregnant ureter, left, at bladder, showing hypertrophy of the sheath of Waldeyer ($\times 10$) b, Pregnant ureter, right, at bladder, same patient as in a, showing hypertrophy of the sheath of Waldeyer ($\times 10$) c, Another type of hypertrophied sheath of Waldeyer, associated with pregnancy ($\times 10$) d, Non-pregnant ureter at bladder. Note small size of sheath ($\times 10$) e, Hypertrophic sheath of ureter at bladder in patient with ectopic pregnancy of 7

weeks' duration ($\times 10$) f, Intramural portion of pregnant ureter, showing that sheath does not arise from the bladder musculature ($\times 25$) g, Non-pregnant ureter, midabdominal spindle. Note compact wall, high mucosa and no dilatation ($\times 25$) h, Pregnant ureter, midabdominal spindle 17 millimeters in diameter ($\times 25$)

(Courtesy of Am J Obst. & Gynec, —Hundley, loc. cit)

dles found encasing the lower end of the ureters, the sheath of Waldeyer. The opinion has been advanced that this hypertrophied sheath is the important causative factor in dilatation of the ureter. If this is correct, the dilatations should be bilateral and should begin at the bladder. Our findings have not supported this view, for we have shown that the changes nearly always begin at the pelvic brim and that the right ureter is much more frequently involved than is the left. (Fig. 2a, b, c, d, e, f, g, h)

The abdominal spindle of the ureter undergoes constant dilatation changes during the

latter months of pregnancy. The wall of the organ is thinned out, the mucosa is normal but quite low, and there is some hypertrophy of the circular layer of musculature.

It was difficult to determine definitely if hypertrophic changes occur in the bladder, as the size of the muscle bundles varies greatly, depending on the bladder being contracted or distended. However, it is our opinion that hypertrophy of the musculature does take place.

The trigone revealed definite hypertrophy of the muscle layers associated with edema and increased vascularity.

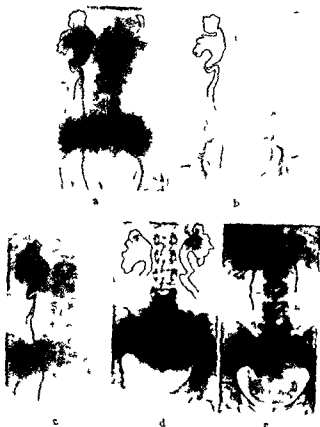


Fig 3 a, E D Indwelling catheter. Right kidney shows a marked hydronephrosis; and by dro-ureter indwelling catheter tip seen in upper end of ureter b L D Indwelling catheter. After 48 hours there is noted a moderate diminution in size of the pelvis calyces and ureter c E D Indwelling catheter. Twenty-four hours later there is noted an increasing diminution in the size of pelvis calyces and ureter d B S Fibroid tumor filling the pelvis, before operation. There is marked dilatation of the pelvis and calyces of both kidneys and both ureters e B S Thirty-eight days later following operation. Pelvis and calyces of both kidneys and ureters have returned to normal (Courtesy of Am. J. Obst. & Gynec. - Hundley loc cit.)

DISCUSSION OF URETERAL DILATATION AND ATONY

In order to determine if pressure played a definite role in the production of dilatation of the upper urinary tract, we decided to repeat the experiments of Lee and Mengert, who had studied the effect of continuous catheter drainage during the last months of pregnancy. They logically deduced that if these dilatations were produced by pressure, the relief of this pressure should allow the urinary tract to return to normal. However none of their cases showed any decrease in dilatation by the use of the indwelling catheter over a period of 74 hours. From their observations they are "skeptical that ureteral obstruction from any cause whatever, is the reason for dilatation of the upper urinary tract in pregnancy."

In our study we allowed the catheter to remain in the ureter 48 and occasionally 72 hours, with a resulting decrease of the dilata-

tion. We found that drainage for 24 hours was not sufficient to produce an appreciable change (Fig 3a, b, c). We also made intravenous urographic studies in the presence of large pelvic tumors and found that if these tumors were large enough to rise out of the pelvis and were of such configuration as to fit the pelvic bowl snugly they would produce dilatation of the upper urinary tract and that after their removal the pelvis and ureter would return to normal (Fig 3d, e).

Many explanations have been presented to account for the greater frequency of right sided ureteral dilatation. This is accounted for, certainly in part, by the fact that the left ureter is protected and cushioned by the overlying sigmoid flexure which is also a causative factor in the production of dextro-rotation of the uterus. The right ureter is also more exposed than the left due to its anatomical course, and therefore is more

easily compressed. The right ureter crosses the iliac vessels at nearly a right angle, whereas the left ureter runs almost parallel to the vessels (Fig 4).

In the intravenous urographic study of the normal pregnant women, which we have just described, it was found that with advancing pregnancy and with progressive dilatation of the ureter, the excretion time of the kidney was markedly retarded, so that frequently a delay of 30 to 45 minutes was necessary before a satisfactory film could be obtained. With this delay of excretion time, there is an associated atony and loss of irritability of the musculature with a resulting urinary stasis. This fact has been well shown by the work of Traut and McLane. These workers have been able to show that there is an increasing atony of the ureter with advancing pregnancy and that, at the end of the second trimester, there is a complete loss of tone with absence of peristalsis. There is a return of irritability during the last month of pregnancy with a period of atony following delivery. However, usually within 6 weeks postpartum the muscular tone has returned to normal.

A SUMMARY OF PHYSIOLOGICAL CHANGES OCCURRING IN THE URINARY TRACT

We have seen that the urinary tract undergoes certain definite changes during pregnancy and with the use of intravenous urography have studied these changes occurring in normal women in the succeeding months of pregnancy and the puerperium. The constant finding has been dilatation of the upper urinary tract and pelvis, the dilatation being more frequent on the right side and nearly invariably beginning at the brim of the pelvis. Following delivery, the urinary tract returns to normal in 4 to 5 weeks. This regression is delayed or never occurs in the presence of marked infection.

Histological studies of normal ureters associated with pregnancy have shown hypertrophic changes of the musculature, most marked in the sheath of Waldeyer. A definite softening process takes place particularly in the wall of the abdominal ureter, with this structure becoming flaccid and easily compressible.

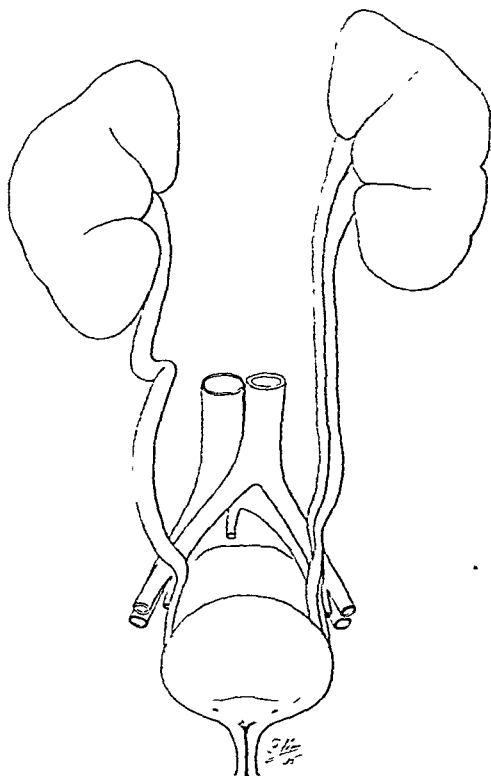


Fig 4. Autopsy drawing of urinary tract, patient dying at term. Note right ureter crossing iliac vessels at nearly a right angle, thus making it prominent and more susceptible to pressure than the left ureter, which runs nearly parallel to the iliac vessels. (Courtesy of Am J. Obst. & Gynec, —Hundley, loc cit.)

We have shown that the pressure of the growing uterus impinges against the ureter, especially the right, at the pelvic brim, and that the resulting ureteral dilatation rarely begins prior to the sixteenth week of pregnancy. To confirm our belief that pressure is a factor in the production of the dilatation, we have seen that continuous drainage of the kidney pelvis with an indwelling catheter permits regression of the dilatation; also that large pelvic tumors cause pressure changes and that after their removal the urinary tract returns to normal.

In addition to these observations, we have noticed that with the advance of pregnancy the excretion time of the kidney was markedly delayed, and it was also noted that the dilated, tortuous ureter showed a decrease in



Fig 5 a Chorionepithelioma in a man primary focus being a teratoma of the testicle (X115) b Section of juxtavesical portion of ureter from man with chorionepithelioma

oma showing hypertrophy of the sheath of Waldeyer even more marked than that seen in pregnancy (X12) (Courtesy of Am J Obst & Gynec —Hundley loc cit)

rhythmical expulsive force due to lack of tone. In our original paper we presented certain evidence to show that the hypertrophic changes in the ureteral musculature, along with the increased vascularity, softening and loss of tone, were due to hormonal activity. The most convincing data were obtained from the autopsy of a man dying from a teratoma of the testicle with generalized metastasis, which proved to be chorionepithelioma (Fig 5a). Prior to operation the

urine had been strongly positive for prolactin on two occasions. The examination of the ureter showed definite hypertrophic changes throughout the entire organ but was most marked in the juxtavesical portion. Here there was tremendous hypertrophy of the sheath of Waldeyer, the greatest external diameter measuring 8 millimeters (Fig 5b). There was no evidence of any dilatation of the urinary tract which should have been present if the hypertrophy of the sheath (Waldeyer) is the etiological factor in the production of the dilatation. It is thought that the luteinizing hormone, prolactin B, is devoid of a growth promoting factor. In order to account for the hypertrophy of the ureter, the action must have been indirect. The prolactin elaborated by the trophoblastic tissue of the chorionepithelioma stimulated the testicle, with subsequent outpouring of growth hormone producing the described changes. This growth change produced by indirect action of prolactin is analogous to that constantly seen occurring in the generative tract of the female infantile mouse following the injection of pregnancy urine. Additional data which would seem to add to the evidence of hormonal activity on the ureter was obtained from an autopsy of a woman dying after an operation for an ectopic pregnancy of 7 weeks' duration. The lower end of the ureter showed a definite hypertrophy of the sheath of Waldeyer and there was no dilatation of the organ observed.



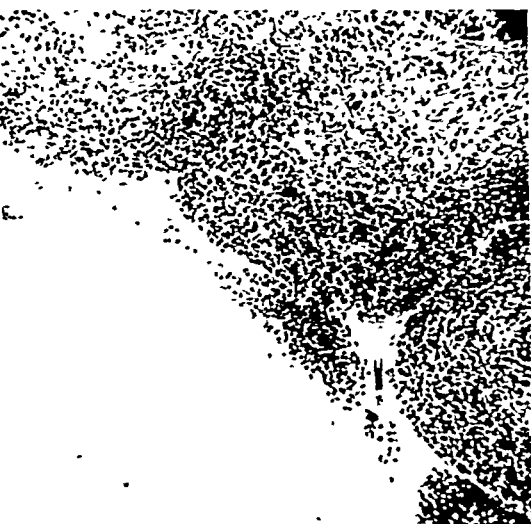
Fig 6 P L Right urogram of patient who came to autopsy. See Figure 7 for illustrations of urinary tract obtained at autopsy.



a



b



c



d

Fig 7. a, P L, Roentgenogram of injected autopsy specimen b, Kidneys and ureters sectioned showed bilateral pyelonephritis, ureteritis and left ureteral stricture 6 cm below the ureteropelvic junction. c, Marked cellular infiltration of the ureteral mucosa d, G S Another example of upper urinary tract dilatation when associated with an inflammatory process

When one considers that the generative and urinary systems arise embryologically from the same anlage, we believe that it is not too speculative to deduce that the same hormones incidental to pregnancy, which produce increased vascularity, softening of the tissues, and hypertrophic changes of the musculature, would produce similar changes in the urinary system. We know that with the advance of pregnancy large quantities of anterior pituitary sex hormone and estrin are found in the urine. The luteinizing substance, designated as prolan B by Aschheim and Zondek, reaches its maximum excretion of 5,000 to 6,000 mouse units per liter of urine during the fifth month of pregnancy, whereas the excretion of estrin in the urine during early pregnancy is comparatively low and ascends to its maximum of 10,000 to 40,000 mouse units per liter in the last month of gestation.

It would seem possible that the urinary tract changes described could be brought about by these 2 hormones, the muscular hypertrophy and vascular changes being dependent upon the growth principle estrin, and the increasing atony of the ureter due to the relaxing influence of prolan B. The hypertrophic changes occurring in the lower end of the ureter in the patient dying following the operation for ectopic pregnancy of 7 weeks duration, were admittedly marked for this early period of gestation when the output of estrin was low. However, this finding does not necessarily preclude the possibility of such an explanation when we know how variable and individualistic the tissue reactions are to hormonal stimulation. Another factor that seems to support the endocrine theory is that following delivery and with the rapid decrease of the hormonal content of the urine, there is a progressive and rather rapid regression of the urinary tract to its normal state. These regressive changes would appear to go hand in hand with similar ones occurring in the generative tract postpartum.

In order to ascertain what effect pregnancy had upon the urinary tract of common animals, Mengert studied the ureters of 42 mammals of 8 species, half of which were pregnant and the other half being used as controls. He concluded from his observations that preg-

nancy has no effect upon the ureters of the animals studied.

Wishing to see what effect prolonged injections of estrogenic substance would have upon the urinary tract of spayed dogs, the following investigation was undertaken. Six healthy, medium sized, female dogs were selected, 2 of which were castrated, and on 1 an exploratory laparotomy was done to rule out pregnancy definitely, the ovaries were not disturbed. These 3 animals received daily injections of ammotin in oil¹ until each had received a total of 5,250 rat units the daily dose being 100 units. For each of these injected animals there was a control, 2 being castrated and the 1 remaining was a normal control for the non castrated injected animal. The summarized results obtained from this short study are as follows:

1. There was no significant change observed in the ureters of the castrated injected animals as compared with the castrated controls.

2. A marked growth of the uterus and vagina was obtained with definite hyperplasia of the endometrium and cornification of the superficial vaginal epithelium. In the urethra of the stimulated animals, the transitional epithelium was changed to a definite stratified type with cornification of the surface epithelium.

These investigations are being continued, for it is impossible to draw any definite conclusions based on such a small series of observations.

From our accumulated data we believe that the explanation for these constant dilatation changes occurring in the ureter is twofold. First, there is a preliminary softening of the ureter brought about by the hormonal activity. Second, the semicystic pregnant uterus impinges upon the prepared ureter at the pelvic brim. When the occasional dilatation begins at the bladder and is bilateral, the hypertrophied sheath of Waldeyer may be the etiological factor. When one observes dilatation occurring with large pelvic tumors, it may be argued that pressure alone is sufficient to cause this change during pregnancy. We are not of this opinion, for it would be impossible for the soft, pregnant uterus to exert ade-

¹Supplied through the courtesy of E. R. Squibb and Sons.

quate pressure on the firm, unyielding and unchanged ureter to bring about dilatation.

BACTERIURIA

After observing that the upper urinary tract during pregnancy undergoes dilatation and atony, ideal etiologial factors in the production of infection, we then began a bacteriological study of the urine of normal pregnant women

It is a well known fact that the normal kidney can excrete organisms with no impairment to itself or the remainder of the urinary system. It has also been noted by many observers that there is a high incidence of organisms occurring in the urine of pregnant women

With the developing stasis in the urinary tract and a high incidence of organisms in the urine of normal pregnant women, there should be a marked frequency of pyelitis. However, we found this occurrence of pyelitis infrequent. We felt that this could be explained by the organisms being for the most part confined to the bladder urine, while the kidney urine remained practically sterile

One of the first thorough bacteriological studies done on the urine of pregnant women was by Victor Albeck, in 1907. He found a very high incidence of organisms in both bladder and kidney urines. Every one of the 30 patients studied showed organisms in the bladder urine, and 70 per cent of the kidney urines were positive, the predominating organism being the colon bacillus. Other workers in this field agree as to the presence of organisms in the urine but their findings differ widely in regard to the frequency of their occurrence. From our observations, some of the discrepancies are more apparent than real, due more to the various interpretations of the findings than actual differences.

The results of several of the investigators are here quoted. Harris and Herrmann report bacteriuria in 74 per cent of their antepartum and 94 per cent of their postpartum patients. Duncan and Seng also found a high percentage of infections, 42 per cent antepartum and 80 per cent postpartum. However, Kinkaid, Dodds, Crabtree, and Prather found the occurrence of infection as low as 3 4 per cent,

6 4 per cent, and 13 per cent, respectively. The lowest incidence of colibacilluria has been reported by McLane and Traut, namely, 6 08 per cent for the bladder and 0 86 per cent for the right ureter.

Several factors enter into the determination of the incidence of organisms in the urine, some of the most important being the volume of urine and the type of culture media used. In the study of apparently normal asymptomatic women, there would necessarily be a small number of organisms present and their recovery would naturally depend upon the volume of urine, whether or not it is centrifugated, and also upon the culture media and duration of incubation. Another factor that has great bearing on the bacterial findings is the technique used in catheterization. Comparative deductions from results of various investigators are also difficult to determine, due to the lack of similarity of methods employed. Even the interpretation of statistical studies may be made to vary considerably in the same group of patients studied, depending upon whether the results are based on the total number of positive cultures taken, often several having been obtained on the same individual, or on the number of patients showing positive cultures.

As the reported results are at such wide variance, and there is such a paucity of comparative investigations between the bladder and kidney urines, we felt that further study of this problem was indicated. The plan of bacteriological investigation was carried out as follows:

1. A study of the bladder urine of 50 normal pregnant women.
2. A control study of the bladder urine of 50 normal non-pregnant women.
3. A cystoscopic study of 50 normal pregnant women with comparison of kidney and bladder urines.

An additional group of 100 normal pregnant women was also studied. but these findings will not be here included, for the methods and technique used were not similar to those of the recorded study.

Only patients who were asymptomatic and gave no history of previous urinary tract infections were used. The specimens were

obtained in the outpatient department, the most careful asepsis being employed. The technique was as follows:

1 Vulva and perineum scrubbed with green soap, sterile water and flushed with bichloride of mercury solution.

2 Labia and vestibule painted with mercurochrome, 5 per cent, and a sterile glass catheter passed into the bladder.

3 The first specimen allowed to escape, tip of catheter flamed, and second specimen collected in sterile tube.

The tubes were centrifuged and all but 3 cubic centimeters of the specimen pipetted off. The specimen was then shaken and 0.1 cubic centimeters streaked on a blood agar plate. Two brain broth tubes were also inoculated, each with 1 cubic centimeter of the urine, one being incubated under anaerobic conditions.

Bladder urine cultures were obtained from 50 normal pregnant women, and the results of the study are given in Table I.

TABLE I—BLADDER URINE CULTURES IN 50 NORMAL PREGNANT WOMEN

Organism	Positive	Percentage
Bacillus coli	3	6
Staphylococcus albus	15	30
Staphylococcus albus and streptococcus viridans	1	2
Streptococcus viridans	7	14
Streptococcus viridans and Neisseria catarrhalis	1	2
Streptococcus viridans and yeast	2	4
Streptococcus anhaemolyticus	1	2
Diphtheroid	1	2
Yeast alone	1	2
Negative cultures	18	36

As will be observed, there were 18 negative cultures obtained. The most important organism as an etiological factor in the production of pyelitis, the colon bacillus, was found 3 times. The *Staphylococcus albus* was found to be the offending organism in 16 instances and the streptococcal group in 12. This entire group of organisms is of low pathogenicity and the organisms are normal inhabitants of the epidermis of the labia and the mucosa of the vestibule and vagina. When one remembers that the external urinary meatus is nearly constantly bathed with cervical and vaginal discharges, it is somewhat remarkable that negative bladder cultures are obtain-

able, for certainly the urethra must contain organisms which are pushed into the bladder by catheterization. The coliform and coccal forms may, of course, under other conditions and locations, be highly pathogenic.

The results will be further analyzed, especially in regard to the incidence of positive cultures on the two types of media used.

A Positive cultures of all organisms on brain broth 33 cultures 64%

B Positive cultures of all organisms on blood agar 18 cultures 36%

C Positive cultures of *Bacillus coli* on blood agar and brain broth 3 cultures 6%

The variation between A and B, namely 14 cultures, is probably due to the difference in volume of urine used, the blood agar plate being inoculated with 0.1 cubic centimeters and the brain broth medium with 1 cubic centimeter, the lesser amount containing fewer organisms. All cultures were negative for strictly anaerobic organisms.

In order to determine if the incidence of the organisms described was peculiar only to the pregnant state, we decided to study a group of normal non pregnant women. Fifty normal, asymptomatic women as controls were selected. It was surprising how many patients in the outpatient department had to be interrogated and examined before the necessary number could be obtained. The results of this study are recorded in Table II, exactly the same methods were used as in the pregnant group.

TABLE II—BLADDER URINE STUDIES IN 50 NORMAL NON PREGNANT WOMEN

Organism	Positive	Percentage
<i>Escherichia coli</i>	6	12
<i>Staphylococcus albus</i>	5	10
<i>Streptococcus viridans</i>	4	8
Anaerobic streptococcus	2	4
Diphtheroid	3	6
<i>Alcaligenes faecalis</i>	2	4
Negative cultures	28	56

As will be noted from Table II, there were 28 negative cultures. Of the positive ones, 6 were due to the colon bacillus, this being twice the number occurring in the pregnant group. The same types of organisms, with the addition of the *Alcaligenes faecalis*, were found, the incidence of the *Staphylococcus albus* being 5 and that of the streptococcus being 4.

Here, as in the first study, the results will be further analyzed in regard to the incidence of positive cultures occurring on the two types of media used.

A Positive cultures of all organisms on brain broth: 22 cultures, 44%

B Positive cultures of all organisms on blood agar: 9 cultures, 18%

C Positive cultures of *Bacillus coli* on blood agar and brain broth, 6 cultures, 12%

The variation between A and B, namely 19 cultures, is probably due to the volume of urine used. All cultures were negative for strictly anaerobic organisms with the exception of 2, these being streptococci.

Comparative observations between the pregnant and non-pregnant group will now follow

A. Positive cultures of all organisms on brain broth in pregnant group: 32 cultures, 64 per cent

B Positive cultures of all organisms on brain broth in control group: 22 cultures, 44 per cent

C Positive cultures of *Bacillus coli* on brain broth in pregnant group: 3 cultures, 6 per cent

D Positive cultures of *Bacillus coli* on brain broth in control group: 6 cultures, 12 per cent

Here it is seen that the incidence of positive cultures in the pregnant group A is 10 more than those occurring in the control group B, 32 positive cultures in the former and 22 in the latter.

The next table shows the difference between the number of positive cultures in both groups when the medium is blood agar and the volume of urine used is 0.1 cubic centimeter. Naturally, the number of positive cultures will be reduced, due to the smaller volume of urine containing fewer organisms

A Positive cultures of all organisms on blood agar in pregnant group: 18 cultures, 36 per cent.

B Positive cultures of all organisms on blood agar in control group: 9 cultures, 18 per cent

C Positive cultures of *Bacillus coli* on blood agar in pregnant group: 3 cultures, 6 per cent

D Positive cultures of *Bacillus coli* on blood agar in control group: 6 cultures, 12 per cent.

The variation between A and B, namely 9 cultures, would seem to indicate that the number of organisms in the bladder urine of the pregnant group is greater than in the control group. It is also noted that the incidence of positive cultures of *Bacillus coli* in the con-

trol group is twice the number occurring in the pregnant group. The observation is of interest, for as we know this organism is greatly responsible for the inflammatory processes occurring during pregnancy. Therefore, one might expect a higher incidence of coliform organisms in the urine of the normal pregnant woman; however, this seems not to be the case in our study of this limited number of urines.

The last procedure in this bacteriological investigation was the cystoscopic study of 50 normal pregnant women, with comparison of the kidney and bladder urines. Due to the fact that *Staphylococcus albus* was found in 20 per cent of the bladder urines examined, a slight change was made in the catheterization technique. Instead of the extensive perineal preparation already described, we now cleansed only the vestibule and inner surfaces of the labia minora, the same solutions as well as the mercurochrome being used. It was thought that in preparing such a large area as was previously done, an increasing number of skin organisms might be brought into the field. This change in technique was of undoubted value, for in this series there was only one culture of *Staphylococcus albus* obtained. Another change in the procedure was to allow the urine to run directly on the media instead of inoculating from the urine collected in a tube. By this procedure, a volume of urine greater than that used in the previous studies was unavoidably allowed to run on the agar slant; therefore, the number of positive cultures here obtained on the blood agar and the brain broth, as will be later noted, nearly equaled each other. In this series the urine was not centrifugalized. With these aforementioned exceptions, the method of obtaining the specimens was the same as used in the previous groups.

The bladder was catheterized to obtain a specimen for microscopic study. Approximately 5 drops of urine were then allowed to run on the blood agar slant and 15 drops into the brain broth medium. The patient was then cystoscoped by the water method. As the possibility of infection in the right kidney urine is greater than in the left, due to the more pronounced dilatation changes in the right tract,

TABLE III—RESULTS IN SERIES A—
15 PATIENTS

Case	Bladder		Right Kidney	
	Blood agar	Brain broth	Blood agar	Brain broth
1				
2				
3				
4	<i>Escherichia coli</i>	<i>Escherichia coli</i>		
5				
6				
7				
8				
9		Diphtheroid		
10	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
11				
12	<i>Escherichia communior</i>	<i>Escherichia communior</i>	<i>Escherichia communior</i>	<i>Escherichia communior</i>
13				
14				
15				

and as we also wished to obviate any unnecessary bacteriological work, only the right ureter was catheterized. Cultures were obtained from this kidney in the same manner as were those from the bladder.

Of the 50 normal pregnant women cystoscoped, 15 were selected in the early period of gestation, up to and including the sixteenth week, whereas the pregnancies of the remaining 35 were more advanced. The reason for separating the group into these two divisions was to determine if the dilatation changes in the upper urinary tract, which become definite about the sixteenth week of pregnancy, would be a factor in producing a higher incidence of organisms in the later weeks of pregnancy.

The cystoscopic examinations showed the usual changes that are found during pregnancy. There was no evidence of cystitis, the ureteral orifices were found somewhat high up in the bladder, and the frequent saddle depression of the superior surface of the bladder, due to the pressure of the enlarging uterus, was observed. These findings in detail have already been described by us in a previous paper.

Tabulated results of the findings in Series A, pregnancies up to and including 16 weeks, will now be presented. Of the 15 patients in this group, there was only 1 who showed an occasional leucocyte on microscopic examination of the bladder urine (Table III).

There were found in this series 11 completely negative cultures which are indicated by the blank spaces. The kidney urines were negative with the exception of 1 positive culture due to the colon bacillus. This organism in this patient was found on all media in the bladder, as well as in the kidney urine. *Streptococcus viridans* and a colon bacillus were found on both culture media in the bladder urine, but the kidney cultures were negative. Also, a diphtheroid was found in the bladder on brain broth media.

Tabulated results of the findings in Series B, pregnancies after the sixteenth week, will now be considered. Of the 35 patients in this group, 6 showed an occasional white blood cell in the bladder urine (Table IV).

In this series 20 negative cultures were found, as shown by the blank spaces in Table IV. As will be noted, only 1 patient showed a colon infection in both the bladder and the kidney urine on all media. Another gave nearly similar findings with the exception that the right kidney culture was negative on blood agar. The only other positive kidney culture was due to the *Staphylococcus albus*, it being positive in the brain broth medium of both bladder and kidney urine. There were 15 positive bladder cultures obtained from 35 patients. Four of these were of the coliform group, while 8 showed gram positive coccoid forms. Of the 3 remaining 2 positive cultures were due to *Neisseria catarrhalis* and the other to a diphtheroid organism. The same types of organisms were found in this series as in the previous one.

The summarized results of the cystoscopic study on 50 normal pregnant women, with comparison of the bladder and kidney urines, are as follows:

The examination of the fifty bladder specimens showed 19 positive cultures for all organisms, namely, 38 per cent. Some investigators base the incidence of bacteriuria on the number of cultures of colon bacilli found

all other organisms being considered as contaminants. Our incidence of bladder colibacilluria is 12 per cent. In regard to the 50 kidney cultures obtained, 4 of them were found positive, thus making an incidence of 8 per cent. Of the 4 positive cultures, the infecting organism was the colon bacillus in 3 and the remaining was the *Staphylococcus albus*. The incidence of the kidney colibacilluria was 6 per cent. Comparative deductions between Series A and Series B cannot be made with accuracy, for the latter is over twice as great as the former. However, there was found no marked variation between the number of positive kidney cultures in each group, in spite of the numerical difference: positive kidney cultures, Series A, 1; positive kidney cultures, Series B, 3. This would seem to indicate that the increasing dilatation of the ureter with atony and stasis, as seen with advancing pregnancy, does not in itself increase the incidence of organisms in the kidney urine.

Final deductions based on this completed bacteriological study are:

A. The incidence of positive cultures for all organisms in the bladder urine of 50 normal pregnant women was 64 per cent on brain broth and 36 per cent on blood agar.

B. The incidence of positive cultures for all organisms in the bladder urine of 50 normal non-pregnant women was 44 per cent on brain broth and 18 per cent on blood agar.

C. The incidence of positive cultures for all organisms in the bladder urine of the 50 normal pregnant women cystoscoped was 36 per cent on brain broth and 32 per cent on blood agar.

The data obtained from these studies would indicate that the incidence of all organisms in the bladder urine of the normal pregnant woman is high, namely 50 per cent of the 100 cases studied. However, this finding loses much of its significance when we note that the urine of the control non-pregnant group also showed a marked frequency of positive cultures, namely, 44 per cent. It is possible that there is a greater frequency of organisms in the bladder urine during pregnancy than in the non-gravid state. However, a far larger series of patients must be studied before this

TABLE IV.—RESULTS IN SERIES B

Case	Bladder		Right Kidney	
	Blood agar	Brain broth	Blood agar	Brain broth
1	<i>Neisseria catarrhalis</i>	<i>Neisseria catarrhalis</i>		
2	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
3	<i>Escherichia coli</i>	<i>Escherichia coli</i>		<i>Escherichia coli</i>
4				
5				
6				
7				
8	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
9	Diphtheroid			
10		<i>Staphylococcus albus</i>		<i>Staphylococcus albus</i>
11	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
12	<i>Escherichia communior</i>	<i>Escherichia communior</i>		
13	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
14				
15				
16				
17	<i>Escherichia communior</i>	<i>Escherichia communior</i>	<i>Escherichia communior</i>	<i>Escherichia communior</i>
18				
19				
20				
21				
22				
23				
24				
25	<i>Streptococcus anhaemolyticus</i>	<i>Streptococcus anhaemolyticus</i>		
26	<i>Streptococcus viridans</i>	<i>Streptococcus viridans</i>		
27				
28				
29				
30				
31		<i>Streptococcus viridans</i>		
32	<i>Neisseria catarrhalis</i>	<i>Neisseria catarrhalis</i>		
33	<i>Escherichia coli</i>	<i>Escherichia coli</i>		
34				
35				

TABLE III—RESULTS IN SERIES A—
15 PATIENTS

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	Blood agar	Brain broth	Blood agar	Brain broth
1				
2				
3				
4	Escherichia coli	Escherichia coli		
5				
6				
7				
8				
9		Diphtheroid		
10	Streptococcus viridans	Streptococcus viridans		
11				
12				
13	Escherichia communior	Escherichia communior	Escherichia communior	Escherichia communior
14				
15				

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Tabulated results of the findings in Series B, pregnancies after the sixteenth week, will now be considered. Of the 35 patients in this group, 6 showed an occasional white blood cell in the bladder urine (Table IV).

In this series 20 negative cultures were found, as shown by the blank spaces in Table IV. As will be noted, only 1 patient showed a colon infection in both the bladder and the kidney urine on all media. Another gave nearly similar findings with the exception that the right kidney culture was negative on blood agar. The only other positive kidney culture was due to the Staphylococcus albus, it being positive in the brain broth medium of both bladder and kidney urine. There were 15 positive bladder cultures obtained from 35 patients. Four of these were of the coliform group while 8 showed gram positive coccid forms. Of the 3 remaining, 2 positive cultures were due to Neisseria catarrhalis and the other to a diphtheroid organism. The same types of organisms were found in this series as in the previous one.

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The examination of the fifty bladder specimens showed 19 positive cultures for all organisms, namely, 38 per cent. Some investigators base the incidence of bacteriuria on the number of cultures of colon bacilli found

catheter for continuous drainage. Despite these usually successful procedures, the patient became increasingly toxic, making it necessary to terminate the pregnancy at the thirty-second week. Unfortunately, the patient died, and the autopsy revealed a bilateral salpingitis, acute generalized peritonitis, bilateral pyelonephritis with marked hydronephrosis and hydro-ureter. There was found a left ureteral stricture, 6 centimeters below the ureteropelvic junction, and marked kinking of the upper third of both ureters.

The greatest degree of dilatation of the urinary tract that we have observed occurred in the presence of an inflammatory process. It is possible that the infection permits a greater degree of dilatation and atony as well as lengthening of the ureter to take place, for here the right ureter measured 34.6 centimeters in length and 21 millimeters in diameter at the pelvic brim, while the left ureter was 33 centimeters in length and 19 millimeters in diameter at the same level. Definite ureteritis was present and in the upper third of the left ureter a definite inflammatory stricture was found (Fig. 6; also Fig. 7a, b, c, d).

In the study of the normal urinary tract with pregnancy there was no instance of elongation or stricture of the ureter observed.

CLINICAL OBSERVATIONS

The symptoms of inflammatory disease associated with pregnancy are for the most part quite typical, and the diagnosis of the condition is usually readily made. The attack is often initiated with pain located in one or both kidney regions, the right being the most frequently involved. As is not infrequent, chills may usher in the seizure and continue throughout the period of intense infection. If one is to be successful in obtaining a positive blood culture, the specimen should be obtained just prior to, during, or just after, the rigor. Due to the associated ureteritis, pain at times is experienced extending down the course of the ureter, with its point of maximum intensity at the pelvic brim. When this occurs on the right side, the diagnosis of appendicitis may be made. At present, with our better understanding of

these urological problems during pregnancy, the unnecessary removal of the appendix is becoming less and less frequent. At times the pain may be intermittent, cramp-like in character, and located in the region of the pregnant uterus, not entirely dissimilar to early small labor pains.

The most frequent and constant symptom complained of is fever, its duration and elevation being dependent upon the severity of the infection. At the onset, the temperature is often quite high, 103 to 105 degrees, and is septic in type. There is also an associated increase in the pulse rate. With a mild infection, if there is no marked or extensive involvement of the kidney, the temperature will remain definitely elevated for only 3 to 4 days. However, its constant elevation without remission over a period of 6 to 8 days indicates extensive damage to the kidney, usually requiring the interruption of pregnancy.

Urinary symptoms are prominent features of this malady, for the most part consisting of frequency, dysuria, nocturia, and strangury. The urine is frequently of a turbid appearance due to the contained pus cells. Infrequently, hematuria may be present. With the intense infection at the onset, the output of urine is usually reduced in amount; this is due to the decreased activity of the swollen, infected kidney as well as to the partial trapping of the fluid by the very edematous ureteral mucosa. In this stage, the urine is concentrated and usually contains many clumped pus cells which are significant of an upper tract infection. However, at times these cells may be quite infrequent.

Gastro-intestinal symptoms of nausea and vomiting are of not infrequent occurrence, and usually abate quite promptly with the subsidence of the inflammatory process. An occasional observation of interest is that of jaundice, which is usually seen with the more toxic states. One patient was seen who was thought to have had acute yellow atrophy of the liver with intense jaundice; this cleared up promptly with appropriate urological treatment.

ANALYSIS OF CASES

This analytical survey is based on a study of 236 patients with inflammatory disease of

fact can be definitely stated. It would seem that the presence of these non pathogenic, or mildly pathogenic, organisms in the bladder urine of the normal pregnant woman is of little consequence and plays practically no role, *except under unusual conditions, in initiating the inflammatory processes in the urinary tract during pregnancy.*

From the cystoscopic study of the 50 normal pregnant women, only 4 of the kidney urines gave a positive culture, 3 of which were due to the colon bacillus. This finding shows that the kidney during pregnancy is for the most part sterile. The changed urinary tract, with its dilatation, atony, and stasis, is definitely more susceptible to the possibility of infection than is the unchanged tract of the non-pregnant woman. However, these changes alone are not sufficient to incite infection. Pyelitis develops only when there is an association of lowered resistance plus an influx of virulent organisms. The incidence of the organisms in the bladder and kidney urine is expressed by some on the basis of the number of cultures of colon bacilli present, on the assumption that the coliform group is the important factor in the production of pyelitis. If we follow this plan of considering all organisms other than the coliform group as contaminants and base our deductions only upon the frequency of this colon group we find that our incidence of colibacilluria of the bladder is 9 per cent and that of the kidney 6 per cent. The predominating organisms recovered belonged primarily to the coliform and gram positive coccal groups the latter predominating. Other occasional organisms found were *Neisseria catarrhalis*, *Alcaligenes faecalis*, and a diphtheroid. All of the organisms isolated from the bladder urine are normal inhabitants of the labial epidermis and mucosa of the vestibule and vagina. It would seem most likely that the vast majority of the organisms found in the bladder urine of the pregnant and non pregnant woman enter through the urethra. The comparative study between the bladder and kidney urines definitely supports this belief. Of the 50 patients cystoscoped, there were 4 positive kidney cultures and 19 positive cultures from the bladder. This would definitely rule out an

ascending infection and most likely a descending type as well.

PATHOLOGICAL OBSERVATIONS

We have shown that with the advance of pregnancy, changes take place in the urinary tract which are ideal for the development of infection. We have also shown that the incidence of organisms in the kidney of the normal pregnant woman is fortunately quite low, namely, 6 per cent. If the normal immunity of the patient is lowered and there is an increase of the invading organisms, an inflammatory process of the urinary tract may occur. This is particularly prone to happen if the patient acquired a pyelitis prior to pregnancy. The urinary tract may become involved by 3 routes of infection, the hematogenous, the lymphatic, and the ascending the first 2 being the most likely pathways. Each theory has its strong group of adherents, however I believe that the majority are of the opinion that the organisms are carried to the kidney by way of the blood stream. The evidence supporting these several theories will not be here considered.

Once the infection has become established in the "prepared soil" of the changed urinary tract, a definite train of symptoms develops, dependent upon the extent of the pathological process. In the presence of mild degrees of infection, pyelitis develops, the inflammatory process being confined to the mucous membrane of the pelvis and calyces. However, pyelitis as a distinct pathological entity is uncommon, for it is usually associated with varying stages of parenchymal involvement, punctate abscesses being frequently seen. This condition of pyelonephritis and also pyelitis is commonly associated with ureteritis the infection being for the most part confined to the mucosa. With an intense ureteritis localized fibrosis may occur, with resulting stricture formation. Carson, in his autopsy study of the urinary tract during pregnancy, found 3 patients who showed definite inflammatory strictures of the ureter. One of them, P. L. No. 1127, had been treated by one of us (J. M. H.) for a severe bilateral pyelonephritis by repeated ureteral dilatation, kidney lavage and the use of the indwelling

side, so that the gravid uterus can fall away from the compressed ureter and thus facilitate better drainage. The knee-chest position is more efficient but often impossible to maintain if the patient is toxic.

If the methods of therapy described prove of no avail, then cystoscopy with ureteral catheterization must be considered. At times, it is most difficult to decide when this method of treatment should be instituted. However, we feel that if after 6 or 7 days of medicinal treatment there is no alleviation of symptoms, ureteral catheterization is definitely indicated. This procedure was performed upon 25 of the 236 patients studied in this series, 10.6 per cent.

Stoeckel was one of the first to show that this method of treatment was of great value in the persistent and toxic type of pyelitis with pregnancy. Prior to this innovation, it was necessary to interrupt many of the pregnancies in order to save the patient's life. However, at present the termination of gestation is of infrequent occurrence. In this series of patients, 11 such interventions were necessary. It has also been observed that patients who show evidence of a rather intense infection may have a spontaneous premature delivery; this unfortunate outcome occurred in 20 patients.

In the severe type of urinary tract infection, ureteral catheterization with the establishment of better drainage frequently brings about most dramatic results. Even after one treatment, the symptoms may promptly subside and the temperature become normal. However, as a rule several catheterizations are necessary before such alleviation of symptoms takes place. If the response to these treatments is not satisfactory, the ureteral catheter may be allowed to remain in the ureter so that continuous drainage may be maintained, and frequent lavage of the pelvis, with dilute solutions of silver nitrate, may be carried out. It is not well to allow the catheter to remain *in situ* longer than 24 to 48 hours, for we find that its prolonged use in the last trimester of pregnancy is conducive to the early onset of labor. The explanation for this occurrence is probably due to the fact that the dilatation of the ureter by the

indwelling catheter causes afferent impulses, which, crossing the pathway of the sympathetic, readily produce a reflex contraction of the uterus, for, as we know, this organ becomes increasingly sensitive to stimuli during the last trimester of gestation, the most important causative factor probably being the cessation of progesterin activity.

Occasionally, in spite of the procedures mentioned, the patient remains severely ill, as shown by a gradual onset of lethargy associated with beginning urinary suppression, an increase of non-protein blood nitrogen, and continued elevation of temperature and pulse. When this situation arises, evacuation of the uterus is necessary. With this accomplished, ureteral compression is removed, good drainage is established and the urinary tract undergoes regression. This procedure was employed 11 times in this group studied and was successful in saving the life of every patient, with the exception of 1.

For the most part, we have always felt that the treatment of pyelitis during pregnancy was a palliative measure, mainly employed so that gestation might go on to term. We have also felt that we could not hope to cure the infection until after the termination of pregnancy, when the urinary tract has returned somewhat to normal and the provocative factors which tend to maintain the infection have disappeared. However, with the introduction of more modern chemotherapeutic agents, it would seem that the sterilization of the urine may be accomplished during the period of gestation. The present methods at our disposal for combating bacteriuria are the ketogenic diet, mandelic acid, and sulfanilamide.

During the past few years, renewed interest has arisen in the subject of urinary antiseptics, initiated in some measure by the work of Shohl and Janney, who showed that the growth of *Escherichia coli* was inhibited by changing the hydrogen-ion concentration of the urine. Some years later, Clark and Helmholtz introduced the ketogenic diet, its essential factor being the high fat content in relation to the carbohydrate component. Due to the incomplete metabolism of the fats, a condition of acidosis is produced with the out-

the urinary tract, admitted to the obstetrical wards of the Maryland University Hospital. With us, the incidence of pyelitis with pregnancy is 3.1 per cent, which corresponds fairly well with findings from other clinics. However, there is a widespread discrepancy observed between these various reports, the occurrence varying from 1 per cent to 14 per cent of normal pregnant women.

In the series of 236 patients reviewed, 136 were primiparae and 100 multiparae. We have noted that the degree of dilatation of the upper urinary tract is greater in the primipara than in the multipara. This may possibly be produced by the greater pressure on the ureter, which is caused by the uterus enlarging in an abdomen whose abdominal wall is less yielding to its growth. As a rule, pyelitis in the primipara is more severe than in the multipara; the temperature is higher, frequently 105 to 106 degrees, chills more frequent, and there is greater pain with more prostration and toxicity. Everyone agrees that stasis is one of the main factors in the production of urinary tract infection and this has a direct bearing on the time of occurrence of pyelitis. We found that pyelitis developed in only 11 patients during the first 16 weeks of pregnancy, for in this period the urinary tract is just beginning to show definite pressure effects and the incidence is naturally low. The frequency of pyelitis increases as pregnancy advances. In the middle trimester there were 32 such infections and in the last period 97, postpartum infections numbered 96.

It was noted that patients who had marked elevation of temperature and who were somewhat toxic were prone to deliver prematurely, in this series, 20 delivered spontaneously, while in 11 the pregnancy was interrupted artificially.

As we know, the colon bacillus is the most frequent offending organism, and so it proved to be in this series. The next most common type recovered was the coccal group.

Several of our patients gave histories of repeated attacks of pyelitis during succeeding pregnancies, however, others stated that they were free of infection during the pregnancies which immediately followed the one with the

initial attack of pyelitis, and that later the infection flared up in subsequent pregnancies. In others there was only one attack of pyelitis with the following pregnancies entirely normal.

TREATMENT

The treatment of the inflammatory lesions of the urinary tract during pregnancy falls into 2 main groups, namely, the medicinal or palliative and the operative or radical. Fortunately, the vast majority of these inflammatory processes respond to the medicinal form of therapy, as shown by this group of 236 patients, all of whom responded to these palliative measures, with the exception of 2, who required more radical procedures for their relief.

The type of therapy naturally depends on the condition of the patient, as evidenced by the extent and severity of the pathology. The great majority of these infections are confined primarily to the pelvic and ureteral mucosa and are frequently associated with varying degrees of pyelonephritis. The proof of the existence of mild degrees of kidney infection is difficult, for it is not until extensive parenchymal involvement has come about that significant changes in the phthalen and the non protein blood nitrogen are observed. For the most part the diagnosis of such a condition must be based upon the clinical findings.

During the acute stage of these infections, conservatism is the all important factor. The elimination of the kidney must be augmented either by the copious intake of fluids by mouth or if not well tolerated in this manner, subcutaneous or intravenous therapy must be instituted. If there is an elevation of the non protein blood nitrogen, as evidenced by nausea, vomiting, drowsiness and gradual urinary suppression the frequent administration of intravenous glucose is of the greatest value. The time honored practice of alkalization of the urine may be carried out although its efficacy is quite dubious as it has no specific action, for the colon bacillus will grow as luxuriantly on alkaline media as on acid media.

Another procedure that may be of value is changing the patient's posture from side to

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pouring of ketone bodies in the urine, chiefly beta hydroxybutyric acid. It has been shown by Fuller that it is this ketone body in the presence of markedly acid urine that produces the desired bactericidal effect. The diet is difficult to carry out, as it frequently produces marked gastrointestinal disturbances which at times are distressing. We have discontinued the use of this diet in the treatment of urinary tract infections during pregnancy, particularly due to the fact that it produces a definite decrease in the carbon dioxide combining power of the blood, a condition not desirable at this time.

Our experience with the use of mandelic acid during pregnancy has been limited as well as not encouraging. This substance which is excreted unchanged is efficacious only in a markedly acid urine, the acidity being accomplished by the administration of ammonium chloride. This type of therapy necessitates the decrease of fluid intake, which would seem not desirable in the treatment of urinary tract infections at this time.

From the clinical and laboratory observations recently appearing from various clinics, it would seem that sulfanilamide is a valuable urinary antiseptic being bactericidal for the coliform and coccal groups, and is capable of rendering the urine sterile during gestation. Helmholtz and Osterberg state that sulfanilamide given by mouth produces a urine bactericidal for the organisms usually found in urinary infections, with the exception of the *Streptococcus fecalis*. Its ease of administration, its action in an alkaline urine, and its successful use in rapidly clearing up infections resistant to mandelic acid make sulfanilamide a urinary antiseptic of great value. Cook and Buchtel recommend the use of adequate doses of sulfanilamide if good results are to be obtained. They administer 30 grains (2 gm) the first day, 40 grains (2.65 gm) the second day, 60 grains (4 gm) the third day, and 40 grains (2.65 gm) each day thereafter.

Kenny and his associates have recently reported their results with sulfanilamide in the treatment of 16 patients suffering with pyelitis with pregnancy, due to the colon bacillus. In every patient treated, except one the drug appeared to bring about a rapid abate-

ment of symptoms and sterilization of the urine, the urine being free of pus and organisms in 2 to 5 days. They report one failure, a patient in her twentieth week of pregnancy, whose urine contained a heavy growth of an atypical coliform organism which proved to be resistant to sulfanilamide as well as to mandelic acid. In this group of patients treated, no other medication was used, neither was the diet nor the fluid intake restricted.

We have been somewhat hesitant in our use of sulfanilamide in the treatment of these urinary tract infections for it is still in the experimental stage and its mode of action is quite obscure. Probably we have been too conservative, but we have been loath to run the hazard of adding a possible toxic manifestation to an already ill patient. The recent literature is replete with accounts of these various manifestations which are at times quite alarming, but personally we do not know of a death that can be definitely attributed to the use of sulfanilamide. Long and Bliss give a note of warning as to the indiscriminate use of this substance, for it has certain serious toxic effects upon the hematopoietic system and they further state that its careless and reckless use is unwarranted and will undoubtedly result in fatalities. Here at the University Hospital Arnold, who has had considerable experience with this type of therapy in the treatment of streptococcal meningitis, believes that it can be used with safety provided the patient's progress can be carefully observed.

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retina, choroid, and sclerotic with one strong scar. The actual area cauterized does not spread, and for this reason is definitely superior to the Guist and Lindner chemical cauterization method, or even the endothermy current used by Larsson, Weve, and Safar.

The operation The location of the retinal tear having been accurately ascertained by one of several methods, and sketches made of the fundus picture, the eye is irrigated with oxycyanide of mercury, 1:10,000 solution, and anesthetized by the instillation of cocaine hydrochloride, 4 per cent solution, or butyn 2 per cent solution, 1 minim, at 3 minute intervals for 4 instillations. A retrobulbar or subconjunctival injection of novocain solution, 2 per cent, 1 to 1.5 cubic centimeters is made, and 1 to 2 drops of adrenalin solution 1:1,000 is instilled to control bleeding. If butyn is used instead of cocaine, the cornea will remain clearer and ophthalmoscopic examination control becomes much easier. The conjunctiva over the area involved is incised parallel to and 10 to 12 millimeters distant from the limbus, and the conjunctival edges are retracted with silk traction sutures or suitable retractors. The exact area in the sclera overlying the tear is carefully ascertained, usually with the aid of an Amsler or Macky marker. The sclera is incised with a fine Graefe knife for a distance of 1 to 2 millimeters in length. If much fluid is present, the knife is rotated to allow escape of same, if little fluid is present, only a small incision is made and the knife is not rotated. The cautery, which has been previously heated to a white incandescence, is now plunged through the incision to the depth of 3 or 4 millimeters in such a way as to touch the retina. It is left in for only 1 or 2 seconds, never more. The conjunctiva is sutured with a single running loose suture, atropine sulphate unguentum, 1 per cent, is instilled, and both eyes are bandaged. The head of the patient is placed in such a position that the vitreous presses against the puncture hole.

The galvanocautery method This method has been extensively used in place of the thermocautery. Fine electrodes, slightly bent at the end, are used. Electrodes made with sharp points may be used to pierce the sclera more easily. Several punctures may be made

before the eyeball softens, the sclera being perforated to a depth of 2 to 3 millimeters, the cautery point being kept in about 3 to 4 seconds. One drawback is the important fact that the heat varies.

The Lindner-Guist chemical cauterization method. Both Lindner and Guist decided upon the use of potassium hydroxide after many poor results following the early successes with thermocautery and galvanocautery methods.

After subconjunctival or retrobulbar anesthesia injections, the site of the tear is marked on the bare sclera, the area is surrounded with a series of scleral trephinations, either a 1.5 or 1.75 millimeter trephine being used. The trephining is done very gradually in layers. Not every trephine opening is touched with the caustic. The caustic application is immediately neutralized with $\frac{1}{2}$ per cent acetic acid. Lastly, the choroid is perforated with a sharp canaliculus dilator.

The complications consist of piercing the choroid and allowing subretinal fluid to escape, and hemorrhage from an injured vortex vein or choroid.

However, large surfaces can be cauterized, especially necessary when large disinsertions are treated. The main disadvantages consist of the requirement of an exact technique of the trephining, the consumption of much time, and hemorrhage from the choroidal vessels.

Lindner used a so called undermining technique for holes in the macula. The idea is an excellent one, but the technique necessary is much involved.

Dialthermy or electrocoagulation This consists of two methods, viz: (1) surface coagulation with blunt electrodes; (2) electropunctures producing coagulation in the choroid.

Surface coagulation was given impetus by the reports from Larsson's clinic in Stockholm. He aimed at coagulating a large portion of the choroid, which produced an extensive retinochoroiditis with resultant closing of the tear. While an accurate localization of the tear is not so necessary with this method, Weve insisted that the electrocoagulations be placed directly over the region of the tear. A ball electrode 2 millimeters in diameter is held lightly against the sclera for 3 seconds, the

THE MODERN SURGERY OF RETINAL DETACHMENT

HARRY S. GRADLE, M.D., F.A.C.S. and SAMUEL J. MEYER, M.D., F.A.C.S. Chicago, Illinois

THE etiology of idiopathic detachment of the retina is in many cases confused, because the predisposing factors are combined. In the first place, there are two outstanding factors that favor the production of retinal detachment—myopia and trauma. Less marked predisposing factors are choroiditis of low degree, and senile degeneration of the retina. These four factors are the most important and either isolated or associated with each other, play a part in most cases of retinal detachment.

Slides of an eye recently examined histologically by Vogt, in which the retinal detachment was only several weeks old, reveal the fact that in fresh detachments there is no evidence of any inflammatory changes as postulated by Leber, Nordenson, Gonnin. There are no evidences of any inflammatory hemorrhages or bloodclots, nor of any scar formation, nor of any strand formation, nor of any inflammation whatever as a cause of spontaneous retinal detachment.

Finally, other predisposing conditions in this disease include hepatorenal insufficiency, dyscrasias, psychic disorders, and ocular fatigue. The causes which may produce symptomatic detachment are tumors, cysticercus, albuminuric retinitis, orbital cellulitis, scleritis, etc.

Recurrences after successful retinal detachment operations are very frequent. The correct percentage is not known at present. Kleiner, Larsson, Vogt, Weve, and others have written about this in the literature. Gonnin differentiates between recurrences which occur 2 to 3 weeks after surgical interference, and those which occur later. In the first cases, he believes that the original tear is not properly closed or sealed, or another tear has been missed or overlooked, or a tear may be present in an area which the ophthalmoscope cannot observe. In most of these recurrent cases, the cause probably lies in the great fragility of the

retina, which tears in a new place as soon as the original tear is sealed down. The fragility of the retina is a very important factor. The operation then becomes a symptomatic treatment. One must not overstep the limitations offered by each individual case, otherwise surgery will be discredited.

We close or seal through operations the end result of the causative factor or process of the retinal detachment, which rarefies or thins the retina and by this means can also lead to formation of tears, through which the vitreous enters behind the retina and results in detachment of the retina in a large proportion of the cases. There is, therefore, no reason why a case that has healed successfully after operation, should not develop a new hole or holes in the immediate vicinity of the healed area, where the retina has become pathologically thin or fragile, with a resultant recurrence of the retinal detachment. Following a recurrence, the surgeon should persuade the patient to have a second or third operation, as the rarefied or fragile area of the retina is usually limited in extent and may be successfully sealed or closed up. If the second eye is functioning properly, it may be more difficult to persuade the patient to have further work done. If the second operation is unsuccessful, or a recurrence develops, it becomes even more difficult to secure the patient's consent for a third or even fourth surgical procedure.

OPERATIVE METHODS FOR DETACHMENT OF THE RETINA

Gonnin thermopuncture method. One, of course, must begin with Gonnin's thermopuncture method which he so ably elaborated upon about 11 years ago. Gonnin chose this method because of the simplicity of instrumentation. This method has many advantages, especially when it is possible to reach the tears without much difficulty and when they are of such a nature that they can be sealed with thermopuncture. The scar, about 4 to 5 millimeters in width, is a firm scar which glues down the

retina, choroid, and sclerotic with one strong scar. The actual area cauterized does not spread, and for this reason is definitely superior to the Guist and Lindner chemical cauterization method, or even the endothermy current used by Larsson, Weve, and Safar.

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applications being kept at a distance of 2 to 3 millimeters apart. A trephine opening or 2 is made in the coagulated area, the choroid perforated with a sharp scissors point, and the subretinal fluid is allowed to escape. The complications are few, except for a definite lowering of tension.

The strength of current used is 30 to 40 milliamperes. Weve used a 3 to 4 millimeter ball electrode with 100 to 150 milliamperes as a rule, the time being 2 to 3 seconds for each application.

Weve technique. Weve later changed from surface coagulation to the electropuncture method. Weve uses fine needles 0.2 millimeter thick and ranging from 0.75 to 1.5 millimeters in length. "Brushes" containing 4 to 5 such needles may also be used. The current used is 30 milliamperes. Longer needles 3 millimeters in length may first be used to assist in locating the tear. These punctures result in a white spot on the retina, about $\frac{1}{8}$ disc diameter in diameter, and are observed ophthalmoscopically. Then follows either the surface coagulation, the multiple puncture method, or a combination of both. A white flat scar results in the region of the tear. The scar is similar in appearance to the thermopuncture method of Gonin. It obliterates the tear and seals the retina down, and does not usually cause the formation of retinal folds and subsequently secondary tears.

The micropuncture method is now universally practiced throughout the world. The coagulation points have been varied by different operators such as the Salfar pins, Walker pins, Gradle electrode, etc. The essential end result is practically the same. The Walker pins require a moderately involved technique while the Gradle electrode is much simpler to use.

The electrolytic method of treatment of detachment of the retina. *katholysis.* Electrolysis was first attempted in the surgical treatment of retinal detachment toward the end of the 19th century. It has recently been revived by Vogt and Imre who have termed it *katholysis*. The main difference between this therapeutic procedure in those days and now is the importance of the accurate localization of retinal tears with the object of closing them through

a barrage of choroidoretinal lesions and sealed aseptically by chemical caustics or through the medium of such physical agents as heat and electricity.

The therapeutic principle of *katholysis* is to effect reaction through the liberation of sodium and hydroxyl ions at the point of the negative terminal which is inserted through the sclera into the choroid.

The technique is similar to that described for diathermy. The negative electrode consists of platinum-iridium needles 1, 1.5, or 2 millimeters in length, depending upon what part of the eyeball they are to be used. The positive electrode is attached either to an Arruga retractor or the patient's limb. Bubbles of hydrogen gas are liberated at the tip of the needle in the choroid. The current may vary from 1.75 to 3 milliamperes and is held in contact for 3 to 4 seconds.

The first puncture in the sclera is made as nearly as possible 2 millimeters behind the site where the retinal tear is judged to be, and the fundus is examined immediately after this. Bubbles of hydrogen gas are seen at the point of perforation of the electrode and these serve for intra ocular localization of the relation of the puncture to the retinal tear. The needles are inserted at intervals of 0.5 millimeters over this area as the scars produced by this method of treatment are small and do not appear to be more than 0.5 or 0.75 millimeter in diameter on ophthalmoscopic examination. The retina is shallow and at the macular and posterior pole of the eye a greyish white, fluffy edged cloud is readily seen at the point of the needle in addition to the bubbles. Surface coagulation with diathermy may be made to surround this area. The sclera is trephined as usual over this area or over the area where the fluid is most dependent. The choroid is punctured with a punctum dilator and the subretinal fluid is evacuated.

In favor of *katholysis* is the precision with which its effect on the ocular tissues is circumscribed. There is no extensive spread of the current and on this account no damage is inflicted on other intra-ocular structures remote from the area of operation. After *katholysis* there are usually not seen any complications such as cystitis,ritis, cataract, and

optic neuritis which follow in some cases in retinal detachment treated by any one of the surgical diathermy procedures.

Ophthalmoscopically the choroidoretinal scars appear to be 0.5 to 0.75 millimeters in diameter, are well localized, and do not appear to cause extensive fibrosis of the choroid and interfere with the absorption of the inter-retinal fluid. This is especially advantageous when operating in the region of the macula. In most cases of retinal detachment treated by katholysis, there are a few fine opacities in the vitreous over the site of the operated area for 3 or 4 weeks, but elsewhere this structure is very little disturbed.

The minute and well localized areas where the caustic effect of katholysis has operated are particularly advantageous in the treatment of a retinal tear at or near the macula where it is essential to avoid widespread damage to the adjacent retina and the optic nerve.

Another advantage of katholysis is its value in localizing the site of the retinal tear. At the point of insertion of the negative electrode through the sclera and choroid, a string of hydrogen bubbles about 2 to 3 millimeters long is to be seen, easily recognizable on ophthalmoscopic examination, these bubbles afford an important mark of the relationship of the puncture to the site of the retinal tear. In the katholysis operation when a retinal tear lies beneath the course of an extra-ocular muscle there is no need to divide it as a needle 4 millimeters long may be used to pierce the muscle fibers and then the sclera and choroid. Division of an extra-ocular muscle is, in some instances, necessary for the purpose of surgical access to post-equatorial parts of the sclera, but for the exposure of the sclera at, and in front of, the equator a muscle may be gently retracted by means of a double loop of No. 1 silk passed around its belly.

There are usually no intense reactions after katholysis with choroidal hyperemia and conjunctival chemosis as sometimes occur after diathermy and render the prognosis of some cases bad. Also there are no dense adhesions formed between the sclera and Tenon's capsule, a feature which makes exposure of the sclera a relatively easy matter if a second operation should prove to be necessary. After

surface diathermy the sclera and Tenon's capsule are so densely matted together that clear exposure and hemostasis are effected only after considerable trouble.

Some recent research work by Weekers on the surgical treatment of retinal detachment has shown the importance of the part played by plugs of organized granulation tissue which, passing through puncture wounds in the ocular tunics, adhere firmly to the episcleral tissues outside and to the vitreous within but not to the choroid and sclera on their way through these structures. The function of these granulation tissue plugs is to act as links between the outer surface of the vitreous and the episcleral tissues, in this manner holding the retina pinned back in juxtaposition with the choroid.

Up to date, insufficient histological examinations have been made after katholysis to ascertain whether this feature has any bearing on the success or failure of the katholysis operation when the negative needle has been deliberately passed into, or just through, the retina during the operation.

Other lesser advantages are concerned with the apparatus, which is simple in structure, reliable, sensitive, portable, and inexpensive. Among the disadvantages may be mentioned the lowered intra-ocular pressure after several punctures have been made with the kathode needle and some inter-retinal fluid has been lost. However, this does not make trephining at the end of operation insuperably difficult for with patience and care it may be effected without any untoward accident. We think that trephining is the most satisfactory method of draining the inter-retinal fluid. A trephine hole takes longer to close than the punctures with micro-pins and other such devices. Multiple fine punctures may all close simultaneously in a relatively short time whereas drainage from a trephine hole carefully placed and fashioned will be effective at least for several days after operation and in some cases for several weeks.

The tenacity of the choroidoretinal scar after katholysis is problematical. Up to date we have had the impression that the scars are too small and feeble to seal effectively a large retinal tear and some moderate sized holes in

the upper half of the retina in the majority of such cases

Katholysis with all its inherent advantages in the ease of operation, use of simple, inexpensive apparatus etc., has one definite disadvantage, and that is the fact that the resultant adhesive scar may not be of sufficient strength to keep the retina in place. We believe that if the area of katholysis is surrounded with a zone of Larsson's surface diathermy coagulation more fibrosis will be formed and a denser

adhesive process produced. Katholysis may also be combined with multiple diathermy micropunctures. The katholysis may be used to seal the tear proper, while the therapy in the surrounding area with either micropunctures or diathermy coagulation or surface diathermy coagulation, will tend to seal the surrounding retinal area more securely to the choroid. This latter method seems to be the best form of treatment offered with our present knowledge.

SOME PRINCIPLES INVOLVED IN SURGERY OF THE EXTRA-OCULAR MUSCLES

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IN general, the principles governing the surgical treatment of the extra-ocular muscles are identical with those governing surgery elsewhere in the body. Because of peculiar anatomical and physiological characteristics, however, there are certain aspects of these principles when applied to surgery of the muscles of the eye which may need reviewing. Surgery of the eye muscles is not a settled affair, and like all surgery it is in a constant state of controversy and change. It is well that this is so because such is the way of progress.

In discussing surgical treatment one cannot avoid stressing first the importance of diagnosis. A thorough and refined differential diagnosis tells us (1) what is wrong, (2) when to operate or when not to operate, and (3) indicates what should be done. It is my feeling that much of the confusion on these 3 points could be eliminated by more careful attention to the differential diagnosis. It is not enough that eyes deviate and have to be straightened. There are reasons why these deviations occur. A study of these reasons will usually determine that certain primary and secondary anatomical and innervational defects exist, and an attempt to evaluate the relative importance of these underlying defects greatly aids in understanding the type of muscular anomaly with which one is faced. By thus classifying cases according to disturbances of function, one should be in a better position to select the surgical procedure to correct them. Often several methods are available to straighten eyes, but one of these will be the best if it is possible to pick it. Differential diagnosis aids in such selection. The aim of modern surgical treatment of the eye muscles is restoration of function rather than mere cosmetic improvement. When function is restored, cosmetic results will be satis-

factory. In a previous paper¹ I discussed this relationship between surgical treatment and differential diagnosis more fully.

Several other factors must also be considered in deciding when to operate. These are the age of the patient, previous treatment, the present status of the condition as to whether it is improving or not, the accessibility of the patient for prolonged non-operative treatment, the type of patient (that is, his personality), and his social and economic status. The age of the patient is not as important as it was formerly supposed to be. Modern procedures, such as the recession operation and the use of catgut sutures, have made it possible to operate safely and accurately even at an early age. When proper non-operative management has been sufficiently tried and the defects are not improving or are becoming more marked, surgery is indicated at any age. Sufficient trial of non-operative measures should perhaps be from 6 months to 2 years, depending upon the individual case. In deciding to operate, one must consider the degree and nature of the strabismus, the condition of the visual apparatus, and the response or lack of response of the latter to treatment. It is granted that many patients can be cured by rather prolonged non-operative treatment, but the circumstances must be favorable. These circumstances are, as has been indicated, the accessibility of the patient for treatment, the type of patient, and the ability of the patient and his family to co-operate intelligently without economic distress. When these factors are unfavorable, it is perhaps better to operate than to permit these eyes to remain out of alinement. Spontaneous recovery of fusion and stereopsis are often noted after surgical correction when no other treatment has been given. I am heartily in favor of orthoptic training when surround-

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¹Prangen, Avery de H. Surgery of the rectus muscles of the eye: selection of operative procedures by differential diagnosis. *Am J Ophth*, 1935, 18 151-156.

the upper half of the retina in the majority of such cases

Katholysis with all its inherent advantages in the case of operation, use of simple, inexpensive apparatus, etc., has one definite disadvantage, and that is the fact that the resultant adhesive scar may not be of sufficient strength to keep the retina in place. We believe that if the area of katholysis is surrounded with a zone of Larsson's surface diathermy coagulation, more fibrosis will be formed and a denser

adhesive process produced. Katholysis may also be combined with multiple diathermy micropunctures. The katholysis may be used to seal the tear proper, while the therapy of the surrounding area with either micropin coagulation or diathermy coagulation, or surface diathermy coagulation, will tend to seal the surrounding retinal area more securely to the choroid. This latter method seems to be the best form of treatment offered with our present knowledge.

muscle pull by adding part of it to the reconstructed tendon. In preparing to alter the pull of a muscle, one must be sure to free it from all secondary attachments to the conjunctiva and the globe, particularly the latter. These secondary attachments, if unsevered, will prevent a muscle from being pulled forward or slipped backward, and may defeat either shortening or recession of a muscle. A tendon cannot be effectively shortened or recessed unless it is so freed. After completely isolating and freeing a tendon and muscle from all attachments, it is possible to resect about 15 millimeters of tissue, if so desired, as in the case of very paretic or paralyzed muscles. Tendon transplants from other muscles to assist in the restoration of action to paralyzed muscles are fairly satisfactory if one is radical enough in his dissection and preparation. In operating on these paralyzed muscles I prefer to shorten the muscle in addition to using the transplants.

In securing fixation or anchorage of the reconstructed tendon to the sclera, the aim is to secure firmness and permanency as well as correct anatomical alinement. Exact mathematical measurement should be employed in placing a new scleral insertion in either recession, resection, or advancement. The normal distances of the various insertions from the limbus of the cornea should be kept in mind and these should be altered exactly as required. Estimated changes are likely to be inaccurate. Various means have been adopted to secure firm anchorage to the sclera. Silk sutures have been used with different combinations and knots. When tension has been created, such as in resection and advancement, I object to multiple silk sutures tightly tied in the tissues because they produce strangulation and invite sloughing and necrosis. Also, silk, when used, has to be removed. This may necessitate further anesthesia, as in the case of children, and also invites the danger of pulling on or disturbing the newly united tissues. Splints, such as gold and steel plates, are used to hold the tendons which have been operated on in proper alinement, and we at the clinic have found the former satisfactory for tendons which have been subjected to extensive resection, thus creating much tension. We do not use gold plates routinely, however, but only in special

cases. At present we prefer catgut sutures for all operations on muscles of the eye, including conjunctival closure. We use plain, non-iodized, and non-chromic gut put up sterile in alcohol, the alcohol being easily rinsed off before the gut is used. We find No. 000 plain gut satisfactory for resections and tucks and we use No. 00000 plain gut for recession and for conjunctival closure. These sutures seem to hold sufficiently long for firm union to take place, and they produce a very minimum of reaction. In addition, they do not have to be removed. Except when buried in a tuck, all knots are tied outside the conjunctiva so that a minimal amount of gut is buried and has to be absorbed. The latter point is, I believe, important in producing less reaction; buried sutures no doubt cause more reaction.

Postoperative care is simple. The first principle of healing is quiet and rest. Both eyes are padded to keep them quiet. A firm, pressure roller bandage is used on the eye or eyes which have been operated on the first day. It is felt that moderate pressure controls the transudation of fluids and possible bleeding. The patient is kept in bed. Dressings are changed the following day and pressure is discontinued. Patients who have had recessions are allowed up and are dismissed from the hospital about the fourth or fifth day, the eye which has been operated on is uncovered the following day. Patients who have had resections and tucks are kept quiet in bed with both eyes covered for about 7 days; they are dismissed from the hospital on the eighth or ninth day with their eyes uncovered. When a muscle has been operated on a second time or when gold plates have been used because of the degree of shortening and the tension produced, the patient is kept quiet several days longer.

I am sure that rather marked and even severe reactions of the parts operated upon are quite often encountered. Such reaction consists of swelling of the upper lid and edema of the ocular conjunctiva. This appears about the third day; it is non-suppurative and reaches its height about the sixth day, when it gradually recedes. This reaction is probably a non-suppurative serous tenonitis of traumatic or chemical origin. While it is practically always harmless, it is nevertheless unpleasant and

ing circumstances are favorable. When orthoptic training is impossible or not feasible, I believe surgery should be resorted to more often. At least these eyes can be straightened and given a chance to overcome amblyopia and develop fusion by themselves when no other assistance is available.

One has a natural aversion to operating on both eyes at one sitting. When the patient is available, it is probably best to operate on one eye and then on the other at a later date. When patients come from a long distance and are unable to return for further treatment, however, it may be necessary to operate on both eyes at the same sitting. Whether to operate on both eyes or one is also determined, of course, by the severity of the defect and whether it is bilateral. When a bilateral defect exists, I think it is more proper to correct both eyes than to unbalance the eyes by trying to obtain correction by operating on one eye alone. In other words, one should attempt to restore normal function rather than to effect mere cosmetic straightening.

The type of anesthesia employed is important to both patient and surgeon, an efficient anesthetic greatly promoting the successful outcome of any operation. With an efficient anesthetic, much less trauma, physical and mental, is encountered and better work is carried out. The physical condition of the patient being satisfactory, I much prefer general anesthesia. It seems most difficult to obtain satisfactory local anesthesia. In the first place the patient is acutely conscious of the operator's every move and of the approach of instruments. Second, pain is caused by pulling on the long anterior ciliary nerves which run forward through the ocular muscles. Third, if the patient has been given sufficient opiates and barbiturates to be insensitive to pain, he might as well be asleep as far as our ability to inspect the eyes as we operate is concerned. At the clinic Dr. Lundy and his associates have developed intratracheal anesthesia to a point where it is eminently satisfactory. By this method the field is left entirely free. Pentobarbital sodium (nembutal) and when permissible morphine, are administered beforehand in adequate dosage to eliminate apprehension and to reduce greatly

the amount of anesthetic consumed. As a result of these procedures the patient comes out of anesthesia quietly and sleeps restfully for several hours. I am, of course, assuming that we have decided before the operating room is reached, by careful diagnosis, just what and how much is going to be done, and we seldom change our plan unless something of an unusual anatomical nature is encountered.

Regardless of the type of operation performed, there are certain fundamental procedures which are common to all extra-ocular muscle surgery. These are the incision, the isolation and reconstruction of tendons, the securing of anchorage or fixation to the sclera, and the use of various sutures and splints.

A properly placed incision giving adequate exposure of the field and room to work is most essential. I prefer a long incision through the conjunctiva, together with free and wide undermining of this tissue so that the important landmarks of the insertion, tendon, and capsule are freely visible. Too small an incision prevents the carrying out of such a procedure. As a corollary I also prefer a smooth and careful closure, using sutures enough to accomplish this. This gives smoother healing and less scarring and granulation. In incising, one should avoid injury to Tenon's capsule and the tendon itself, for all of these structures may be needed in the reconstruction. In incising and in isolating and reconstructing tendons one must have due regard for tissue welfare and aim at a minimum of trauma, which is a fundamental principle of all surgery. On the other hand one must be radical enough in these maneuvers to attain proper reconstruction. The best surgery at times may well be the most radical for one must not stop short of attaining the objective.

In reconstructing tendons one must consider whether he is faced with normal tendons, poorly developed or overly developed tendons, anomalous tendons or tendons that have previously been operated on. The type of tendon which is uncovered naturally determines in addition to the diagnosis just what type of reconstruction should be attempted. The nature and development of Tenon's capsule should also be noted, for it can often be altered to lessen muscle pull or can be used to reinforce

THE TRACHOMA SITUATION IN CHINA

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IT IS a great honor to be asked by your governing council to present a paper at your clinical congress. On receiving the invitation to speak on trachoma I found myself in the embarrassing situation of not being able to think of any new facts concerning this disease. Obviously, I am not expected to speak on the etiology of trachoma. Undoubtedly, you are well informed about the steady progress of the work of Thygeson, Julianelle, Harrison, and others, which has been done here in the United States, and which has carried the solution of the etiology of trachoma to a point where we hope it will soon cease to be a problem.

Obviously it would be like carrying coals to Newcastle if I spoke here on the modern methods of combating endemic and epidemic trachoma. You are all familiar with the methods and results of the campaign against trachoma which Gradle and his associates have been conducting in southern Illinois aided by the generosity and understanding of Governor Horner.

The most discouraging thought, however, for one who is asked to speak on trachoma at this time must be that only one year ago MacCallan, probably the most experienced clinical trachomatologist of this era, published a monograph which contains practically everything worth knowing about trachoma.

Through the repercussions in the newspapers of the Sino-Japanese conflict, I became aware of a growing interest of the world at large in the fate of the 470 million inhabitants of the Republic of China. The Chinese, who constitute the great majority of the population of the enormous country, have been described by one of their best connoisseurs, Dr. Hsien Wu, as "over-peaceful, non-persevering, non-progressive, non-enterprising, and easily contented with the environments in which they find themselves." It occurred to me that

you might be interested to hear how the Chinese have been defending themselves against one of their domestic enemies, namely, against trachoma.

There are only a few publications dealing with trachoma in China from the viewpoint of modern western medicine, and these publications are not easily accessible. I have had direct contact with Chinese affected with trachoma in the outpatient department and hospital of the Peiping Union Medical College, an institution with which I have been connected for the last 4 years. The patients seen there come chiefly from Peiping and its vicinity, that is, from the province of Hopei. In the Peiping Union Medical College, there is a special trachoma clinic for the employees of the institution. This clinic offers an excellent opportunity for continued study of trachoma cases, because attendance at this clinic is compulsory for trachomatous employees.

On various journeys through China, I have made observations with regard to the incidence and the general character of trachoma in rural districts of the provinces of Hopei, Chahar, and Shansi, and in the cities of Shanghai, Nanking, and Hankow. Before I shall try to tell you what my stay in North China has taught me with regard to trachoma, it might be well to investigate whether or not we agree in regard to the principal characteristics of trachoma.

Trachoma is a contagious chronic inflammatory disease of the human conjunctiva and cornea, in the course of which 4 typical stages can be distinguished. Severity and outcome of the disease vary greatly, due to differences in the virulence of the infectious agent and in the susceptibility of the individual. Pathologically, the disease constitutes an infiltrative, granulomatous form of inflammation which is followed by scar formation. The disease is self-limited. Partial removal or destruction of the conjunctival infiltration by surgical means, grattage and massage of the

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makes one apprehensive lest increased tension from the edema may interfere with the stitches and healing. When this occurs, I have found intramuscular injection in the buttocks of boiled, whole, raw milk effective in hastening resolution of the edema, 5 to 10 cubic centimeters of such milk which has been boiled for 5 minutes, is used. On the second or third day after operation, when such a reaction is seen to be impending, an injection is given, and one injection is as a rule, sufficient. I believe such a procedure is more effective than iced or hot compresses which necessitate excessive manipulation of the eye which has been operated on. The less we manipulate and interfere with healing the better I believe will be the result.

Speaking in general of the after or end results of muscle surgery, I believe that I have seen far more under correction than over correction. If anything, one tends to do too little rather than too much. As I said earlier in this paper, I believe that we must be radical enough to attain our objectives. The immediate result is likely to be disappointing, as the muscles which have recently been operated on are sore and limp, and the final result may not be apparent for several weeks or even months, as

there is much readjustment which must take place in the complex muscle team of the two eyes after any muscle surgery has been performed.

SUMMARY AND CONCLUSIONS

A refined differential diagnosis is the first requisite of extra-ocular muscle surgery. In deciding to operate, one should be guided not so much by the age of the patient as by the degree and nature of the strabismus, the condition of the visual apparatus and the response or lack of response of the latter to non-operative treatment.

In reconstructing tendons, while due respect should be paid to tissue, one must nevertheless be radical enough to attain the desired objective.

Exact measurement should be used in altering tendon insertions on the sclera, plain gut sutures are preferable for securing scleral anchorage, and intramuscular injection of boiled, whole, raw milk has been found useful in controlling undue postoperative reaction.

It is felt that the surgeon is more likely to under correct than to over correct in operating for strabismus.



7.3 per cent were discovered to suffer from trachoma, whereas among the students over 10 years of age 28.9 per cent were affected with the disease. The incidence of trachoma increases considerably during the school age.

The incidence of trachoma in Peiping is not known, but such a figure would hardly be significant because of the large admixture of transient elements in the population of Peiping. More significant are the figures pertaining to rural districts with a stable population. Of such districts very few have been examined by competent ophthalmologists. Great variations as to the frequency of trachoma have been encountered. H. J. Howard has reported figures as high as 68 per cent (one village in the southern part of the province of Hopei). I have not found a village in the vicinity of Peiping in which the incidence of trachoma is higher than 45 per cent. The percentage of trachoma among the eye patients of the Peiping Union Medical College (2) is of some significance, because the majority of these patients come for the relief of diseases other than and apparently not related to trachoma. Between May 1, 1928, and April 30, 1929, 4,150 new eye patients were admitted to the eye out-patient department of the Peiping Union College; of these patients 33.6 per cent were found to have trachoma. According to H. T. Pi's estimate, at least one-third of the population of China suffer from trachoma.

With regard to the epidemiology of trachoma in China several factors are worth mentioning. Acute epidemics of ophthalmia, which are the principal propagators of trachoma in the Near East, are fortunately rare in North China. During my stay in China I did not witness a single epidemic of Koch-Weeks conjunctivitis. An epidemic of gonorrheal ophthalmia which broke out in one of Peiping's municipal institutions for the poor was described by my associate, Dr. T. H. Luo. There are, however, other factors which act as propagators of trachoma in North China. Water is very scarce and, therefore, expensive. For a family of 5 members the amount of water necessary for cooking and drinking may easily cost from 50 to 75 cents a month, an amount which, for the lowest classes, may represent one-fifth of the entire

income of the family. These classes must, therefore, be economical with the use of water. "The people not only wash their faces in the same basin and use not only the same towel, but also the same water" (H. T. Pi).

The dryness of North China accounts for its dustiness. The layer of loose sand which covers most of the land is stirred up by the slightest wind and carried into the conjunctival sac and into the respiratory tract of the inhabitants. Besides, North China is notorious for its dust storms which, as a rule, rage for 3 days and 3 nights and put the love of the foreigner for China to a test. This dustiness of the country accounts for the prevalence of mild degrees of chronic traumatic conjunctivitis which, in turn, causes a tendency to rub one's eyes frequently.

Another factor which propagates the spreading of trachoma in China is the so called "common-towel habit." The customers of restaurants, theaters and tea-houses are given towels soaked in hot water with which they wipe their faces, necks, and hands. If the towels were put in boiling water after each customer no objection could be raised to this habit. Actually, most of these towels go through the hands and over the faces of several customers before they are put into hot water again.

The mode of infection in North China must be that of direct transfer of virus from one eye to the other. The dryness of the climate and the absence of acute epidemics permit no other way of infection. The direct transfer is made possible through the intimate symbiosis between affected and unaffected people under conditions of great uncleanness. The uncleanness has its reasons in the dearth of water and in the poverty, ignorance, and carelessness of the population.

The result of all these and probably other factors is an incidence of trachoma of approximately 33 per cent. Commonly one finds that one or two members of a large family, despite intimate contact with the other members, have escaped the infection. Unilateral cases of trachoma are also not uncommon in North China. I feel that these observations alone warrant the presumption that the infectivity of trachoma in North China and the

hypertrophic conjunctival surface, and the application of various non specific drugs, namely mild corrosives, astringents, antiseptics, and tissue poisons, definitely hasten the course of the disease

Some parts of this definition may require modification or amplification. The involvement of the cornea in the trachomatous process has been included in the definition because Wilson, Thygeson, Busacca and others have shown that thorough examination with the slit lamp and the corneal microscope reveals evidence of pannus not only in every case, but also in very early stages of the disease. It is true that microscopic pannus is less common. The difference between microscopic and macroscopic pannus is hardly more than a quantitative one, expressing a difference in the severity of the disease. I, therefore, prefer to speak of pannus as a regular manifestation of the disease instead of calling it a complication. The exceptional cases in which the severity and extent of the pannus is out of proportion to the degree of conjunctival inflammation may deserve to be called complicated.

It might be argued that a definition of trachoma should include the statement that trachoma is a clinical and etiological entity. Such a statement will find general acceptance if one thinks of folliculosis and follicular conjunctivitis in this connection. These two diseases always prove distinguishable from trachoma if they can be observed for some time. Inclusion conjunctivitis of the newborn and of the adult, however, appears to be so closely related to trachoma that a non committal wording seems appropriate at this time, especially since Lindner suggests the name "paratrachoma" for that disease. Clinically, the difference between trachoma and inclusion conjunctivitis is marked. Corneal involvement and conjunctival scars are rare in inclusion conjunctivitis besides, the latter tends to be milder and shorter in course than trachoma. Etiologically, however, a close relationship between the two viruses must be admitted.

As another omission from the foregoing definition of trachoma, the fact might be considered that monkeys inoculated with material

obtained from human trachoma, regularly develop a disease which resembles follicular conjunctivitis in man. This is doubtless a significant fact because only the viruses of trachoma and of inclusion conjunctivitis and the diphtheria bacillus cause visible changes of the conjunctiva of the monkey. One must, however, be careful in naming this experimental disease of monkeys and in drawing analogies between it and human trachoma. Statements like "Trachoma has been produced in monkeys" or reference to the "trachoma of monkeys" meet with decided opposition on the part of important clinical trachomatologists.

The definition of trachoma as given at the beginning of this paper seems to comprise all the important features of trachoma on which we all agree and can, thus, serve as a basis for the discussion of problems pertaining to trachoma. The trachoma situation in China will be discussed under the following headings: (1) the incidence and epidemiology of trachoma, (2) the severity, course, and outcome of trachoma, (3) the treatment of trachoma.

INCIDENCE AND EPIDEMIOLOGY OF TRACHOMA IN CHINA

Following MacCallan, a rough idea of the incidence of the disease may be obtained by dividing the world into 4 categories according to the degree of trachomatous incidence: (1) practically universal, (2) very common, (3) occasional with heavy local infections, (4) rare. MacCallan puts China in group 1 where trachoma is practically universal. Also in group 1 are Palestine, Egypt, the Levant, Morocco, Algeria, Tunisia, Arabia, Persia, Iraq, Mongolia, Indochina, parts of Russia, Sardinia, Corsica, Cyprus, Malaya, and Polynesia. My feeling is that China should not be put in the same group with Egypt or Palestine.

The available data on the incidence of trachoma in China are incomplete and partly non representative. In the schools of Peiping one of my associates Dr S P Chang found, for children and youths between the ages of 5 and 15, an average incidence of 18 per cent. These students came socially from the middle classes. Of the children under 10 years of age

trachoma and militates against cure." I found it very difficult to assess the influence of such coexistent diseases upon the severity of trachoma. Only in the case of coexistence of trachoma and phlyctenular disease I became convinced that the two diseases were influencing each other unfavorably and that treatment of each disease was necessary to obtain noticeable improvement of trachoma or of the phlyctenular keratoconjunctivitis.

A sequela of trachoma which is characteristic for China is the plasmoma (10) of the conjunctiva, a well circumscribed nodular or sausage-shaped tumor which arises from the fornices or from the semilunar fold and consists of densely packed plasma cells. Although several types of such tumors are known to the pathologists, the plasmoma which is confined to the conjunctiva represents a definite clinical entity. Its relations to trachoma were established in countries where trachoma is less common than in China (Kreibig). In those countries, it seems, very few cases of plasmoma have been observed in which the presence of trachoma could be ruled out. Beyond this intimate relation to trachoma, nothing is known about the etiology of these plasmomas.

In our clinic, such plasmomas are very common, apparently more common than in any other trachoma country. All patients seen in one clinic exhibit signs of trachoma in its late stages, but there are, apparently, no relations between the severity of the trachoma and the occurrence of the plasmoma.

Thorough studies of our cases have revealed no systemic or local abnormal findings which could be correlated with the occurrence of the plasmoma. Pathologically, the plasma-cells which make up most of the tumor show moderate degenerative changes. A tendency toward hyalinization is fairly pronounced in the stroma and in the vessel walls of these tumors. The bulk of the tumor, however, even after duration of a year or longer, retains its typical plasmacellular structure.

These plasmomas respond little or not at all to contact radiation with radium. Our standard treatment is, therefore, surgical and consists of attempts at radical, but submucous, extirpation. Local recurrences are very rare.

TREATMENT OF TRACHOMA

Because of the small number of ophthalmologists who are practicing in China, mass treatment is the only form of treatment from which the country at large can benefit. While I have endeavored to do my share in the planning and working out of adequate measures of mass treatment for various localities in China, I have become more and more aware of the advantages which individual treatment possesses over mass treatment. I have become convinced of the immense value of daily clinical examinations of a small number of trachoma patients by the same ophthalmologist.

The benefit derived from such an individual scheme is mutual; as the clinical observations become more accurate, the doctor acquires a better understanding of the disease and, *pari passu*, the effectiveness of the treatment, based on such an understanding, increases.

Following the recommendation of Salinger (Chicago), local treatment of the trachomatous conjunctiva with quinine has been tried in my department and found to be very effective in the follicular forms. After the drug had been used for 2 to 3 months, the clinical picture became stationary and some of the patients developed a hypersensitivity to the drug.

Speaking in general, I have learned that the system (adopted by MacCallan and others), of alternation of treatment periods with copper sulphate, mercury bichloride, and chaulmoogra oil rubs, combined with surgical procedures of the order of grattage, is the most satisfactory one from the patient's as well as from the ophthalmologist's point of view.

In stubborn cases of stage III, I have also performed multiple microcoagulations (with the Weve needle) of the subepithelial island of infiltration. In almost every case this treatment resulted in a very noticeable improvement, that is, in a definite move toward stage IV.

In very severe cases of stage II or III, I have always kept the possibility of an extra-ocular systemic factor in mind and have carried out whatever measures were recommended

susceptibility of the Chinese are relatively low

During my stay in China I saw 4 cases of trachoma acquired by foreigners in China. In each of these 4 cases the infection could be traced back to a definite source, a case of active, amply secreting trachoma in a Chinese with whom the foreigner had had intimate contacts. The trachoma of the foreigner was in these 4 cases severe, in 2 of the cases it was confined to one eye.

SEVERITY, COURSE AND OUTCOME

My predecessors at the Peiping Union College, H. J. Howard and A. Pillat, the latter of whom now holds the chair of ophthalmology at the University of Graz, expressed the opinion that trachoma in China, as a whole, is of mild character and has a tendency to eliminate itself. This has, as far as I know, become the unanimous and fully warranted opinion of all ophthalmologists who have worked in China. The mildness of the disease is borne out by the fact that at least 25 per cent of the trachoma cases seen in a clinic or in a small population actually show a very mild form of trachoma and, as far as one is allowed to judge from the history of these patients, they never had a more severe degree of the disease. Students who come to us for the correction of refractive errors and give no history of even the slightest degree of conjunctivitis in the past and who have never received any conjunctival treatment, often show a mild stage (MacCallan, group 4) of trachoma. This finding is by some authors described as spontaneous cure. Spontaneous cure of mild or moderately severe trachoma is so common in China and other countries that I consider it as one of the characteristics of trachoma and have incorporated it in the definition given at the beginning of this paper. Trachoma is, in principle, a self-limited disease. The significant point in the aforementioned observation is that intelligent Chinese belonging to the middle classes often go through trachoma without noticing it. The commonness of this event in my opinion, again indicates that the disease tends to be mild in China.

The explanation that the Chinese does not become aware of his own trachoma because

he is less sensitive and has a lower degree of pain sense than other races is only partly pertinent. The pain sense of the Asiatic is, according to Jefferys and Maxwell and according to my own observations, just as acute and just as highly developed as that of any other race I know. It is only the lowest social class, the coolie class, which gives the opposite impression, but with them "it is not a question of suffering less pain, but of bearing it better. They are inured to lives of want, hard conditions, struggle and cheerful submission. They expect to suffer and expect little relief and care" (Jefferys and Maxwell).

In these lowest social classes it may very well happen that the subject's symptoms of mild or moderately severe trachoma are suppressed by the hardships which these people encounter in their struggle for a living.

Another observation which illustrates the mildness of trachoma in China is the great rarity of pronounced deformities of the tarsus. The milder degrees of entropion and trichiasis are, of course, common but a single Hotz operation, very often without removing slices of the thickened tarsus, is sufficient to restore normal position of the lid border permanently. Moderate degrees of posterior symblepharon are common and become noticeable and annoying when intra-ocular operations have to be performed. The shortening of the upper fornix is very often of such a degree that only a maximal muscular impulse will cause a sufficient degree of depression of the globe.

Xerophthalmus due to trachoma is very rare in North China.

The severe forms of trachoma in North China comprise about 25 per cent of the trachoma cases seen in a trachoma clinic. In a population their incidence is probably considerably lower. Just like the ophthalmologists in other countries, we have been interested to know whether it is the virulence of the infectious agent or the susceptibility of the patient which makes the trachoma in these cases take a severe course. According to MacCallan "some of the most severe cases of trachoma are seen in individuals, who are the subjects of ankylostomiasis, bilharziasis, malaria, or other debilitating diseases. Severe oral sepsis also contributes to the severity of

THE SURGICAL TREATMENT OF VARIOUS TYPES OF LESIONS IN THE PETROSAL PYRAMID

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PATHOLOGICALLY it has become established that there are distinct variations in the location of the characteristic lesions comprising the infections of the petrosal pyramid. Therefore it seems fitting when determining the type of operation that shall be undertaken to meet the indications a given case presents, that the otological surgeon shall be able exactly to diagnose the location of the lesion which he is attempting to eradicate. Likewise it seems that there is small justification for allowing the surgical approaches toward eradication of purulent lesions in the petrosal pyramid to fall into the category of routine surgical procedures. Finally, so exact can the particularization in selecting the exact technique to meet a given situation be made, that the surgery employed should never be more extensive nor more radical than is absolutely necessary to accomplish the ends sought. Only in the rarest of instances is the clinical history so obscure, the laboratory data so insufficient, and the operating surgeon so at a loss as to the exact location of the lesion, that a general exploratory operation—that is, a surgical search of the interior of the petrosal pyramid for a lesion—is necessary.

Like infections of the appendix which should be adequately met by surgery before an intraperitoneal rupture takes place, or like a mastoidal infection which should be handled adequately by a surgical technique before rupture intracranially has taken place, so petrosal infections should be met with proper surgical intervention while the lesion is still intrapetrosally situated, and long before a rupture has taken place to add an extrapetrosal purulency to the gravity of the situation. That this can be done my personal experience

with 46 consecutive cases proves. It is both possible and feasible, and is the only rational method of meeting the surgical problem.

Petrosal infections, like any other infections in the body, have a tendency to heal spontaneously, and many petrous pyramid involvements do heal spontaneously. It is necessary that the surgeon confronted with a given case shall first determine whether his case is *progressing* or whether it is in *regression*, and in the process of healing. Space does not permit a detailed discussion of the details of diagnosis of petrosal lesions, or of the exact data on the differential diagnosis between petrosal lesions that are progressing and those which are in the process of spontaneous healing. Suffice here briefly to outline the important factors concerned in such a differentiation.

The clinical picture of a developing or advancing petrosal lesion may be summarized in the recognition of the significance of the reappearance of an aural discharge after a period of its cessation or its uninterrupted continuance after the performance of a complete simple mastoidectomy. Pain sensations appear periodically from branches of the first branch of the fifth cranial nerve with increasing severity and intensity, and with decreasing periods of intermission between them, until this pain is constant. There is present a low-grade temperature and an increasing general "malaise" and there is also present occasional transient inflammatory or irritative reactions from the living and functioning labyrinth. Concomitantly there may appear signs of involvement from other cranial nerves—from the sixth, the ninth, or the tenth—and occasionally also the facial nerve is involved. Added to these clinical findings is a roentgen film depicting varying degrees of halisteresis of the pars petrosa to complete obliteration of evidence of any bone structure. All these factors taken together form the

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by the internist syphilologist, otolaryngologist, or dentist whom I consulted. Occasionally I have noticed improvements of the trachoma following treatment of a general debilitating disease in the sense of MacCallan, or following the removal of definite foci of infection.

Thus, I have learned to consider such measures as a valuable adjunct in the treatment of severe cases of trachoma. The evaluation of these measures from the scientific point of view is still very difficult.

SUMMARY

The trachoma situation in China is, in several respects, a characteristic one. The outstanding fact is the mildness of trachoma in the Chinese. Compared with the other public health and economic problems which the Chinese government has to face, the author, although an ophthalmologist, is ready to ad-

mit that the trachoma problem is of minor importance.

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the external auditory canal. Consequently, the differentiation between anteriorly and posteriorly located lesions becomes a rather simple matter. In a given case in which a simple complete mastoidectomy has been performed, a search of the postauricular wound will often reveal a purulent discharge in excess of what one would expect from a post-mastoidectomy healing wound, while the discharge from the middle ear is less intense and under less marked pressure. Therefore, when the pus seems to be coming from the mastoid wound, the first step in surgical therapy is to make a complete search of all the surfaces comprising the base of the petrosal pyramid—all of which can be done through inspection of the walls of the ordinary simple mastoid wound area. The skin may have to be re-opened, the granulation tissue which sprang up from the bone is removed, and the bone surfaces are carefully searched for fistulas. Generally one will be found either under the arch of the vertical semicircular canal or along the prefacial mastoid cell tracts leading toward the bulb. If fistulas in either of these areas or any other area emptying posteriorly through the base of the petrosal pyramid are located, the adequate surgery to handle this type of lesion is to be found in the enlargement of these fistulas, the curettement of their walls, and the drainage of the purulent accumulations from which they lead. No radical mastoidectomy is necessary to reach these lesions because they are accessible through the wound area left after the performance of the technique embraced in the simple mastoidectomy. Handled in this way I have had no cases in which a simple mastoidectomy was sufficient to locate and drain purulent fistulas, and recoveries ensued.

Failing to locate a fistula as described, radical mastoidectomy becomes the next necessary step; particularly so if, when inspecting the post-simple mastoidectomy wound area, no pus is found coming with more intensity than before from any particular wall area, or, on the other hand, there is now present a pulsating discharge from the middle ear spaces, pouring into the external auditory canal—evidence of pus under pressure which is apparently not coming from the

mastoid antrum or the epitympanic space, for then it would naturally drain into the open mastoid cavity. Here then there is presented an anteriorly lying lesion—one lying anterior to the cochlea. This cannot be reached with surgery limited to the technique comprised in the simple mastoid operation because the anterior cochlear area is not exposed by such a procedure. In my opinion, also, the dural approach should not be employed to reach it because then the dura is exposed to a trauma which increases the gravity of the prognosis. The most rational procedure is a complete tympanomastoidectomy to locate these lesions anterior to the labyrinth, and this naturally will include anterior supracochlear as well as subcochlear and precochlear situated lesions, and of course it will include enclosed empyemas of the so called pyramidal apex.

The performance of the radical tympanomastoidectomy will demonstrate the middle ear spaces full of detritus, pus, and granulations. Once these are cleared away, fistulas located in the tubotympanic orifice can be reached and drained successfully. My experience to date comprises 25 cases in which radical mastoidectomy was performed, fistulas found, enlarged, and their contents successfully drained.

Having performed a tympanomastoidectomy and finding no fistula, the symptoms meanwhile persisting—roentgen films continuing positive—the situation then presented logically leads to the deduction that the case presents the data upon which the diagnosis of an enclosed empyema of the so called pyramidal apex is present. Be certain that the case presented is one in which the lesion has become seated on a pneumatized temporal bone before making this diagnosis positively. Having made it, I believe that the operation of election to enter the petrosal pyramid and evacuate the enclosed empyema is that devised by Almour (1). This consists in removing the tensor tympani muscle from its bed and freeing the space between the Eustachian tube and the channel of the tensor tympani, and entering the petrosal pyramid at this point. There is pus under pressure from the inside, and a very slight opening into this tissue is soon rewarded by a gush of pus, and the

fundamental elements of a clinical picture which we recognize as indicating petrosal pyramid involvement

The paramount features differentiating a case in progression toward an intracranial involvement from one in regression or in the process of healing may be summarized as follows. A case is in progression when the symptoms of pain in and around the eyes change from a periodically present sign, and become persistent, eventually to cease suddenly altogether, likewise, the aural discharge which has been persistently present since the commencement of the symptoms from the petrosa, also quite suddenly stops or decidedly lessens in amount—the pus is finding egress elsewhere, when the transitory phenomena continue to present themselves with more frequent repetition, and when, in addition, a transient photophobia becomes evident, when a late appearance of a homolateral abducens palsy occurs or if such an abducens palsy were present earlier—present even before the simple mastoidectomy was undertaken—it does not show any immediate signs of improvement when in the face of a feeling of general well being, other and additional cranial nerves become involved, finally, when the usual signs of meningeal irritation appear there is slight pain in flexing the neck upon the chest, the patient becomes increasingly irritable, refuses personal “administration,” and “wants to be left alone,” indications of intensity of “malaise” and the whole appearance, attitude and behavior of the patient indicate to a competent clinician that the patient is sicker than before—this in the face of an afebrile condition, absence of eye pain, and a decrease of the aural discharge

On the other hand, a petrosal lesion is in recession when the pain in and about the eye, instead of suddenly ceasing gradually diminishes both in intensity and in duration of its periodic attacks, the intervals between its attacks are longer, likewise the aural discharge, instead of suddenly stopping, is gradually lessening in amount and there is less evidence of pulsation pressure noted otoscopically, when constant competent supervision and observation show that there are no transient phenomena presented due to irritative

reactions from vital structures located within the pars petrosa, when abducens palsy is present, it unquestionably shows itself as improving, lastly, when by attitude, behavior, and appearance, the clinician can be sure that the patient “begins to look better,” takes an increasing interest in his surroundings, and shows an improved morale. Under such circumstances the petrosal lesion is receding and spontaneous recovery is to be expected

Finally, when a petrosal lesion is recognized primarily every effort should be devoted to its exact localization, and a brief consideration of the factors entailed in making such a determination is in order

The surgeon, having diagnosed a case of petrosal lesion and then being confronted with the problem of its evident progression, must determine upon a procedure to stop further progress of the lesion. In the majority of cases, the surgeon is faced with a situation which develops after simple mastoidectomy. While it is true enough that petrosal infections are complications of tympanic involvements, the dramatic clinical picture of the mastoidal infection overshadows and beclouds the less intense petrosal tissue reactions, and these latter become significant only after the dramatic episode of the mastoid infection has been removed. Now, an attempt should be made to localize the petrosal lesion because upon the success of this localization will depend the selection of the type of surgical intervention logically to be undertaken to reach the purulent lesion in the petrosal pyramid. If one takes the bony labyrinth as a structure which is a fixed landmark, always constant in its position in the temporal bone, it is possible roughly to divide the lesions which occur posteriorly to the labyrinth and those that occur anteriorly to the labyrinth. Post labyrinthine lesions have a natural tendency to drain backward into the mastoid wound cavity. They do not seem so straggles to affect the middle ear structures and do not usually drain into the tympanic cavity. Anteriorly lying lesions—that is lesions lying anterior and internal to the cochlea—have a natural tendency, on the other hand, to drain into the tympanic cavity and the pus finds egress through the membrana tympani into

tions are all devised to keep the surgical field within the limits imposed by the boundaries of the temporal bone and no uninfected tissue need be touched, and no pus need be drained into sterile areas from the purulent contents of the petrosa. To do so adds extra hazards to a situation already grave enough.

Finally, every otological surgeon must be competent to perform all the recognized techniques upon the petrosal pyramid, so that he may select the one suitable for a given lesion, rather than be perfect in one procedure and habitually perform it, whether or not it meets the indications presented. Surgery, of course,

should be as conservative as adequacy will permit. True conservative surgery is ideal when it reaches its objective. Surgery which fails to accomplish this goal is neither conservative nor adequate. It is futile.

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establishment of a surgical fistula which, subsequently enlarged, drains the contents of the empyema without bringing the purulency into contact with dura or other vital tissue structures

To date I have performed the Almour technique 8 times for an enclosed empyema of the petrosal apex. In all of these cases the integrity of the cranial cavity has been protected, and it is to this added factor that I attribute the excellent results that have followed.

There are cases which are seen too late, there are cases in which signs of meningeal invasion and infection are present, which are evidently progressing and which present intracranial symptoms in spite of drainage of fistulas. Furthermore, there are cases in which intracranial rupture occasionally has taken place prior to their reaching competent observation, or prior to clinical recognition of the petrosal lesions, finally there are cases in which a rupture takes place into the posterior cranial fossa area anterior to the cochlea, and as far as I know there is no surgical procedure which will permit both an inspection of the mesial walls of the petrosal pyramid and the location and adequate handling of a posterior fossa extradural lesion except the technique recently suggested by Lempert (2, 3). This technique is a modification and an improvement on that advocated by Ramadier. It consists in the removal of the tympanic plate which is the anterior bony wall of the external auditory canal below the petrosquamous suture. Bringing into view the carotid artery, working away from the artery the bone of the petrosal pyramid is removed piece by piece until its entire interior is under direct visual inspection. To make room, the tegmen tympani and the wall supporting the dura of the middle cranial fossa are removed. Perforations on the posterior fossa wall are disclosed if present, and may be handled just like perforations in the mesial wall of the mastoid process. To date I have performed this operation 3 times with no injury to the functioning of the mandible, and with complete recovery of the patients.

In the technique of managing petrosal infections it thus becomes evident that one meets

increasing severity of symptoms with a proportionately more extensive surgical attack, and only in the last instance is it necessary to invade the cranial cavity surgically.

Summarized, my cases to date consist of 46 cases of proved purulencies of the petrosal pyramid. Of these, 10 were cases in which the lesion was located posterior to the labyrinth. In 21 cases the lesion was located anterior to the labyrinth. In 4 cases there were combined anteriorly and posteriorly lying lesions. Seven times I found an enclosed empyema of the petrosal pyramid. Among these cases 11 times meningitis was present prior to my operative attempts and of these 11 cases of meningitis, 4 died. Among the other cases there were 4 additional deaths, in all there were 8 deaths, 37 cases were cured, and summarizing these cures—10 were cured through the performance of a simple mastoidectomy combined with the location and drainage of fistulas, 25 required radical mastoidectomies combined with the location and drainage of fistulas, 8 times I used the Almour technique and 3 times I used the Lempert technique, in both the Almour and the Lempert procedures, a radical mastoidectomy is a necessary step in the technique.

CONCLUSIONS

Petrosal lesions are vastly different from each other, and no routine procedure is commonly applicable to all of them. The integrity of the cranial cavity should be protected from all hazards—even those of a surgical nature—and no lightly conceived technique should be undertaken to reach intrapetrosal parts by violating the integrity of this cavity and endangering its contents. The application of elaborate techniques to reach the petrosal pyramid through the uninfected tissue of the neck or of the pharynx, is not based on much actual experience. They may be characterized as "cadaver operations" rather than practical surgical procedures, and should not be attempted to handle any of the lesions that petrosal pyramid infections present, because all lesions can now be reached by a proper selection of the type of operation to reach the locality where the lesion is located intrapetrosally. These opera-

able proof that the squamous cell carcinoma may arise from the epithelial lining of the Eustachian tube. In one of my patients, a male, aged 34, who complained of a feeling of fullness in one ear and demonstrated changes in the tympanic membrane, examination failed to disclose a lesion in the nasopharynx although the presence of one was perfectly obvious because of carcinomatous metastasis to the cervical nodes. Repeated biopsies from the nasopharynx in the region of the Eustachian tube failed to reveal the primary cancer. Postmortem examination, however, showed extensive destruction of the base of the skull and a carcinoma within the Eustachian tube, but no malignant invasion of the epithelial structures of the nasopharynx. I strongly suspect that a goodly number of such lesions, which encroach upon the cranial nerves and produce lymphatic metastasis to the cervical glands, arise from the epithelial lining of the Eustachian tubes but remain obscure for the duration of their life. Their clinical behavior points to the fact that they tend to migrate toward the jugular foramen with ravaging effects upon osseous tissue and profound disturbances of the cranial nerves which lie in their path. We cannot emphasize too strongly the fact that malignant lesions of the nasopharynx show a predilection for the lymphatics about the Eustachian tubes and find in this pathway an easy approach to the base of the skull. Of practical importance, therefore, is the observation that these new-growths often assume enormous proportions and consequent destructive behavior long before there is unmistakable evidence of their existence. It is this clinical characteristic that is frequently responsible for our failure to recognize the presence of these lesions until signs referable to one or more of the cranial nerves dominate the picture. Malignant disease of the nasopharynx presents a most provoking clinical problem and one with a prognosis as futile as that of cancer in any field within the domain of the otolaryngologist.

SYMPTOMATOLOGY

One of the earliest indications of a neoplasm in the nasopharynx is pain vaguely referred

to the posterior nares or more frequently reflected downward along the lateral wall of the pharynx or into the ear. This pain is usually sharp and lancinating in character, occurring in intermittent twinges as observed in the typical forms of neuralgia. Associated with this disturbance is a persistent vague sense of discomfort within the ear. The patient complains of an annoying feeling of fullness or a stuffy sensation in the ear, and inspection of the tympanic membrane frequently reveals those changes which point to a disturbance in the ventilation of the tympanum. The drum head is retracted, liver-colored, and occasionally casts a bluish tinge disclosing the effects of negative pressure in the tympanum with associated circulatory disturbances within the middle ear and Eustachian tube. When these signs and symptoms are the result of neoplastic invasion of the nasopharynx, the indications of metastasis to the posterior cervical lymph glands occur with amazing regularity.

In a series of 40 cases of malignancy of the nasopharynx, 11 patients, or 27.5 per cent, came to the clinic complaining of swollen glands in the neck. It was the first evidence of the disease in a large proportion of our cases and was present in 60 per cent of our group at the time the diagnosis of malignancy was definitely established.

It is to be noted that the following symptoms or clinical findings are usually the first indications of neoplastic invasion of the nasopharynx and the occurrence of any one or a combination of them should excite the suspicion of the presence of such a lesion: (1) glandular swellings in the posterior cervical chain; (2) pain referred to the ear or throat; (3) unilateral deafness or a stuffy, full sensation in the ear; (4) changes in the tympanic membrane.

We must not fail to emphasize the importance of these signs and symptoms. Too frequently, the otolaryngologist passes them by without recognition of their significance as early manifestations of malignant disease and without careful scrutiny of the nasopharynx. An appalling number of patients suffering from this affliction have failed to obtain a correct diagnosis, because the consultant did not

MALIGNANT NEOPLASMS OF THE NASOPHARYNX

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ALTHOUGH much has been said concerning malignant disease of the nasopharynx, the subject is one which possesses innumerable opportunities for clinical and laboratory investigation. Controversial opinions concerning the pathological derivations of neoplasms of the nasopharynx, changing views referable to the spread of the disease, and diverse judgments in regard to therapeutic measures to be employed in the treatment of this malady, justify an evaluation of our present day knowledge and permit us to make another presentation of this subject. Perhaps I may prove this text worthy of reiteration by endeavoring to plow under superfluous and redundant postulations, and retain for correlation that knowledge and information which is of practical value in the recognition and treatment of this disease. To this end I shall bend my further efforts.

Malignant tumors of the nasopharynx may be classified into 4 groups, depending upon their tissue derivatives and mode of origin. The first is the carcinoma developing from the epithelial structures of the nasopharynx, second, the sarcoma, taking its origin from the connective tissue elements, third the lymphoblastoma, arising from lymphatic structures, and last, the tumor of teratological origin, representing misplaced or supernumerary cell collection which may proliferate and undergo malignant degeneration. The last type, namely the teratoma, should not be classified, perhaps, with the preceding neoplasms because they may take their origin from any or all of those elements which form the anlage of the first 3. Nevertheless, they are occasionally found in the nasopharynx undergoing malignant alteration and should be given recognition in a clinical study of this character.

The vast majority of malignant neoplasms encountered in the nasopharynx are epithelial

in origin and fall into the group of squamous cell carcinoma. We know little or nothing concerning the etiology of these lesions. Whereas we may theorize on the causes of carcinoma of the lip, the etiology of malignancy of the larynx, and the factors which influence the development of cancer of the skin, we are entirely devoid of an explanation for the growth of a malignant tumor high within the vault of the nasopharynx. A careful analysis of the histories of 40 patients who were the victims of malignant new growths in the nasopharynx, failed to reveal etiological factors of even the remotest significance.

While their cause remains a mystery, we have made clinical observations of much interest on their growth and behavior in the nasopharynx. It is a noteworthy fact that these neoplasms show a striking tendency to infiltrate upward, erode bone, and eventually disturb those structures which pass through the basal foramina. Lymphatic metastasis to the nodes of the posterior cervical chain occurs early in the progress of the disease, while extension by continuity of tissue is almost invariably toward the base of the skull. Seldom does one see such a lesion creeping downward along the lateral wall of the pharynx, and only in the very late stages of the disease is there sufficient forward extension to produce symptoms referable to the nose.

We have all seen the squamous cell carcinoma appear as a lesion no larger than a pea within the fossa of Rosenmüller and much to our amazement discover in a radiographic examination of the skull extensive destruction of the sphenoid and temporal bores. One usually finds, on palpation of the neck, a metastasis to the nodes of the posterior cervical chain at the time of the initial examination of the patient. Occasionally one observes that the lesion has taken its origin from the mucous membrane of the sphenoidal sinus and has caused early involvement of the abducens and optic nerves. Then, too, there is unusual

TABLE I.—INITIAL COMPLAINT IN 40 CASES OF MALIGNANCY OF NASOPHARYNX

	Cases	Percent
Pain in head, ear or throat.	14	35
Cervical swelling	11	27.5
Deafness, fullness in one ear	5	12.5
Nasal obstruction	4	10
Nose bleeds	2	5
Double vision	1	2.5
Paralysis of face	1	2.5
Swelling of face	1	2.5
No eye, nose, throat complaint	1	2.5
Total	40	

TABLE II.—SYMPTOMS OR PHYSICAL FINDINGS AT TIME DIAGNOSIS WAS MADE

Symptoms or findings	Cases	Percent
Cervical swelling	24	60
Pain—head, ear, throat	20	50
Unilateral deafness	15	37.5
Changes in M.T.	10	25
VI N. Paralysis (3 bilateral)	8	20
V N. impairment	5	12.5

alveoli being separated by fibrous septa. The architecture of these growths was cystic and there appeared to be a tendency to form the reticulated structure of the adamantinoma. In one of the tumors, colloid was observed within the cystic spaces. In the other, there were duct-like structures with side branches suggestive of pituitary remains.

It is to be noted that in the embryological development of the hypophysis a stalk is formed which connects Rathke's pouch with the oral cavity. This stalk finally separated from the gland and epithelial remains is found in adult life somewhere between the sphenoid bone and the epithelial structures of the nasopharynx. This vestigial remnant of the epithelial tract, the pharyngeal hypophysis, forms the embryological anlage of the anterior pituitary lobe.

It seems quite proper to assume, therefore, that the two tumors before described, developed from the remnants of the hypophyseal duct and were, for that reason, teratological in origin and classified in that group of hypophyseal tumors to which the name "cranio-pharyngioma" has been given.

Tumors which have their origin in notochordal cells are occasionally found at the 2 extremities of the spinal column where the notochord is enclosed in the bodies of the

TABLE III.—SYMPTOMS OR PHYSICAL FINDINGS AT TIME DIAGNOSIS WAS MADE

Symptoms or findings	Cases	Percent
IV N. paralysis	4	10
III N. paralysis	4	10
Discharging ear	4	10
Nasal obstruction	4	10
Nose bleeds	4	10
VII N. impairment	3	7.5
Exophthalmos	3	7.5

TABLE IV.—SYMPTOMS OR PHYSICAL FINDINGS AT TIME DIAGNOSIS WAS MADE

Symptoms or findings	Cases	Percent
Loss of vision	2	5
VIII N. involvement	1	2.5
IX N. involvement	1	2.5
X N. involvement	1	2.5
XII N. paralysis	1	2.5
Swelling of face	1	2.5

vertebrae and in the intervertebral discs. A group of 52 cases has been reported in the literature, of which number 12 were located in the region of the nasopharynx. Some developmental disturbance, or possibly trauma in later life, may liberate the notochordal cells from their investiture of the bone or cartilage. When thus liberated, they become free to proliferate and grow into tumors of large proportions. They are slowly infiltrating lesions of low malignancy, possessing an irresistible tendency to recur after operations which appeared to effect their complete removal. They are observed twice as often in males as in females and their presence is usually recognized during the middle years of life. Microscopically, the lesion is divided into lobules of various sizes by connective tissue strands and surrounded by a thick, fibrous capsule. Focal hemorrhages may arise from the small vessels within the trabeculae. The cells of the parenchyma vary with the degree of degeneration. In the younger parts of the lesion the individual cells are clearly differentiated and are observed to be round or polygonal, closely arranged, and of a distinctly epithelial character. The cells present varying degrees of vacuolation ranging from small cells with almost homogeneous cytoplasm, to large cells containing a nucleus and a surrounding ring of cytoplasm, with a group of vacuoles of very large size. In the older parts of the tumor the differentiation of the cells is impossible and

take the time to make a complete examination, or failed to give the proper interpretation to the symptomatology. A small lesion, developing within the office of the Eustachian tube and occurring in an individual with refractory throat reflexes, sometimes offers a most perplexing problem in diagnosis. Nevertheless, when signs and symptoms challenge a thorough examination of the nasopharynx, we must use all available means for inspecting this region adequately. Palpation, examination of the reflected image in the nasopharyngeal mirror, direct inspection through the nasopharyngoscope, and biopsy studies, when painstakingly and meticulously performed, will not fail to establish the presence or absence of a nasopharyngeal lesion in the vast majority of cases. In our series of 40 cases, the interval between the first symptoms and the diagnosis ranged from 1 month to 5 years. The average duration of symptoms before the diagnosis was made, was 15 months, and 10 of the 40 patients had been subjected to some type of operation for relief of symptoms before the correct diagnosis was established. Do not pass over, therefore, without careful scrutiny, those early signs and symptoms which point to neoplastic invasion of the nasopharynx.

We cannot review this subject without simple mention of that most interesting group of neoplasms which we classify as tumors of teratological origin. A variety of such lesions found in the nasopharynx are the result of congenital disturbances of development, or the misplacement of embryonal cells. In one instance, the new growth may develop from a mass of misplaced cells, in another, aberrant structures may undergo proliferation with the formation of a teratoma which may subsequently pass through the degenerative changes of malignancy. The etiological influence is vaguely referred to as some disturbance or irregularity of the mechanics of embryonic development.

In this connection, it is to be remembered that neoplasms of a malignant character may arise from developmental disturbances of epithelial tissue. In the nasopharynx for example, we may observe an adenocarcinoma originating in the region where squamous cell

epithelium alone is found in adult life. There can be but one explanation for such a phenomenon, namely, the excitation of columnar epithelium which was carried over as cell collections from the time of early embryonic growth. In the embryo, the nasopharynx is lined with columnar epithelium and some disturbance in the mechanics of development may cause it to persist until adult life. Subsequently these cells, remnants of embryonic growth, may undergo a wild proliferation and give rise to the pathological changes of an adenocarcinoma. In one of my patients, a female, aged 16 years, a tumor mass about the size of a hickory nut sprang from the vault of the nasopharynx. The lesion had been responsible for frequent epistaxis and a feeling of fullness and stuffiness in both ears. Biopsy demonstrated an adenocarcinoma with papilliferous alterations, obviously a lesion arising from columnar epithelium in a region which normally contains a squamous cell type in adult life. Such a new growth may give rise to considerable confusion concerning its histogenesis until one becomes familiar with the occurrence of bizarre neoplasms in many parts of the body, resulting from some irregularity in the processes of embryonic development.

In the past 22 years, 2 cases of a tumor of pituitary origin occurring in the nasopharynx have come to my attention. They are to be regarded as neoplasms of great rarity because a diligent search of the literature has failed to disclose a record of a tumor of similar nature. One occurred in a female, aged 40 years, who presented an enormous tumor in the posterior wall of the nasopharynx, causing symptoms referable to the ears and nose, the other was seen in a woman, aged 45 years, who gave a history of pain in the right eye and severe hemorrhages from the right side of the nose. The lesion was a soft, encapsulated tumor which filled the nasopharynx, protruded into the anterior nares, and produced a proptosis on the right side.

Both of these lesions presented similar pathological pictures consisting of soft, elastic tumors without capsules and showing a tendency to infiltrate the neighboring tissues. Both presented an alveolar grouping, the

HOARSENESS

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FEW symptoms occur more frequently and are so universally disregarded as that disturbance of laryngeal function which we recognize as hoarseness. Hoarseness may well be defined as the danger signal of the larynx. Early recognition of the possible significance of this symptom may be responsible for the saving of many precious lives. Numerous conditions in their inception appear so trivial that little attention is given them. This is particularly true of hoarseness, because it occurs so frequently as a complication of a common cold, subsiding spontaneously, that little attention is given it. Any case of hoarseness lasting over a period of 2 weeks deserves and should have a thorough examination with the laryngeal mirror, for it is only by such a procedure that an early diagnosis can be made in cases of tuberculosis, syphilis, carcinoma, and tumors of the larynx. The importance of an early diagnosis cannot be stressed too vigorously as many of these conditions in their early stages are amenable to treatment. The presence of hoarseness does not always indicate the existence of a serious condition within the larynx. It does indicate, however, that the accurate approximation, equal tension, and synchronous vibration, which is so necessary for normal phonation, has been disturbed.

Jackson and Coates¹ enumerate over 60 causes producing hoarseness. Visualization of a few of these causes by means of color motion pictures affords an interesting study and creates a more lasting impression than it is possible to obtain by any other means.² Screen presentation of a large variety of such lesions is obviously advantageous, not only for the teaching of the student, but also for the benefit of the general practitioner into whose hands come most of these cases seeking relief. Not only should the general practitioner be made to appreciate the importance of voice changes, but the public at large should be made to realize that persistent hoarseness is the danger signal of the larynx. The general surgeon, over a period of years, has conducted a campaign of education in which women have been made to

realize the significance and seriousness of a lump in the breast. As a result of this campaign the mortality from cancer of the breast has decreased considerably. The laryngologists today are faced with the launching of a similar problem of education in which the public must be made to realize that persistent hoarseness is the danger signal of the larynx. It is the first symptom presented by intrinsic carcinoma of the larynx. The general practitioner and the public should be made to realize and appreciate the importance of voice changes. By waging a campaign of education we can make the public "voice conscious" and "hoarseness conscious." When this has been accomplished we may expect to see a large percentage of cases of carcinoma of the larynx in their early stages.

Hoarseness unaccompanied by pain, cough, or discomfort is frequently ignored by the patient and sometimes by the physician until more alarming symptoms appear. Regardless of how trivial hoarseness may seem, it should always be regarded as serious until proved otherwise, and the patient should always have the benefit of a laryngeal examination. As a rule a simple examination by means of a laryngeal mirror will be sufficient to establish a tentative diagnosis. Co-operation on the part of the patient is essential for successful examination and for this reason direct laryngoscopy is the method of choice when handling children. The suspension laryngoscope has given me such excellent results that I continue to use it in all cases in which direct laryngoscopy is indicated. It may be used under local or general anesthesia. My preference for the latter is responsible for the fact that the majority of my cases are given general anesthesia.

Probably the most frequent type of hoarseness seen both in adults and children is that produced by an acute laryngitis following a cold or an excessive use of the voice. Acute laryngitis with subglottic involvement is a rather common clinical picture in young children. This condition is better known to the laity as croup. This type of case readily responds to proper management. Diphtheria frequently produces dyspnea with accompanying hoarseness. This clinical picture is now seen less frequently since the introduction of toxoid as an immunizing agent. Among other conditions producing hoarseness in children we

From the Eye, Ear, Nose & Throat Hospital, Tulane University.

Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.

¹Jackson and Cortes. *Diseases of the Nose, Throat and Ear*.

²At this point a color motion picture film was presented showing pathological conditions within the larynx causing hoarseness.

the appearance is now that of a highly vacuolated syncytium

The treatment is surgical excision of the lesion, followed by some form of radiant energy. The prognosis, however, is very unfavorable for the spheno occipital group of chordomas and various reports in the medical literature show that the average length of life for the untreated cases is about $2\frac{1}{2}$ years from the time of identification of the lesion

TREATMENT OF MALIGNANT LESIONS OF THE NASOPHARYNX

My meager experience with 40 cases of malignant new growths of the nasopharynx leads me to conclude that treatment is exceedingly futile and the prognosis hopelessly discouraging. We have used radical excision, electrocoagulation, x ray and radium therapy in various combinations to meet the indications that appeared to be present and only one of the 40 patients is alive at the expiration of 2 years. This patient is the 10 year old girl to whom I have already referred who presented an adenocarcinoma of the nasopharynx which was classified as a lesion of teratological origin. The mortality among our typical cases of squamous cell carcinoma of the nasopharynx is 100 per cent and no therapeutic measures we employed seemed to combat satisfactorily the destructive influences of these lesions. Perhaps our discouraging results may be attributed, in part, to late diagnoses. It is true that most of our patients came to us 15 months following the initial signs and symptoms and demonstrated extensive invasion of the cranial bones. The gravity of such find-

ings is clearly understood. Nothing could offer a less sanguine prognosis than evidence of malignant infiltration of the osseous structures of the skull.

SUMMARY AND COMMENTS

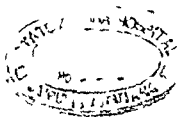
1 The common malignant lesion of the nasopharynx is the squamous cell carcinoma. Tumors of teratological origin undergoing malignant alterations likewise may be found in this region.

2 Early diagnosis is dependent upon the recognition and proper interpretation of signs and symptoms which occasionally antedate the gross appearance of the lesion. In this connection, pain, cervical gland enlargements, and symptoms referable to the ear are to be given their true significance.

3 There is an irresistible tendency for neoplasms of the nasopharynx to extend upward and invade the base of the skull. Paralysis of cranial nerves thus occur, but they are late manifestations of the disease.

4 The diagnosis is frequently a most provoking problem because of one's failure to identify a small lesion in the fossa of Rosenmüller or for the reason that the neoplasm remains hidden within the Eustachian tube or beneath the surface epithelium of the nasopharynx.

5 All of the usual therapeutic measures for cancer have been advocated, but the prognosis remains hopelessly futile. There appears to be no adequate means of arresting its upward invasion with consequent involvement of osseous tissue. The deadly behavior of bone cancer is fully appreciated by all.



central origin frequently produce a paralysis of one or both vocal cords.

The most significant of all changes that may take place in the larynx is that produced by malignant growths. It has well been said that hoarseness is the danger signal of the larynx. Unfortunately, too few of the laity and the profession heed this danger signal. Few malignant lesions throughout the entire body present any earlier symptoms than intrinsic carcinoma of the larynx. The earliest manifestation of intrinsic carcinoma occurs on the vocal cords, usually at the junction of the anterior and middle thirds, producing at first only a slight alteration in voice. This represents the earliest form of intrinsic carcinoma which can be detected, and the first symptom presented is hoarseness. If this early warning symptom were accorded the recognition it deserves, many lives would be saved. It is generally agreed that 80 to 82 per cent of intrinsic carcinomas of the larynx respond favorably to treatment, yet the study of statistics shows that a very large percentage of these cases die from cancer of the larynx. The cause of this high mortality rate is the fact that an early diagnosis was not made. In recent years cancer has assumed a much higher mortality rate. From this we may conclude that malignant lesions are increasing or that our diagnostic methods have improved. It is certainly true that the laryngologists who are manifesting interest in cancer of the larynx are undoubtedly seeing more of these malignant conditions than in former years. One wonders whether this is a natural increase or the reward for years of work and interest manifested in this particular subject. It is deplorable, however, that such a large percentage of cases of carcinoma of the larynx referred to the laryngologist are so far advanced that little hope for a cure can be offered. The first symptom of intrinsic carcinoma is present early; the diagnosis presents little if any difficulty, and most important of all is the fact that this condition is curable in its early stages. Carcinomas occurring in other portions of the larynx aside from the vocal cords are as a rule not discovered early because they produce no alteration in voice function and no discomfort until the lesion is well advanced.

Concurrent with the diagnosis of carcinoma of the larynx must be the mode of handling such lesions so as better to effect a complete cure in as large a percentage of cases as possible. Obviously different stages of the growth will necessitate varying modes of attack. Briefly, those cases of incipient, intrinsic carcinoma consisting of an outcropping on the anterior or middle third of the

vocal cord respond most successfully to intra-laryngeal surgery. These are purely surface lesions confined to the vocal cord and could well be designated as cordal carcinomas. The tumor is small and there is no lagging or fixation of the cords. Suspension laryngoscopy permits one to remove and cauterize the base of these growths successfully. An excellent exposure of the laryngeal structures is obtained, and it is comparatively easy to remove these early growths by dissection followed by cauterization. When the growth has extended beyond the limits just described and two-thirds or more of the cord is involved, more extensive surgery will be necessary. As the growth extends in the long axis of the cord, there is an induration of the base and occasionally an early lagging of the cord is present. This is the type of case which demands thorough study and differentiation. Laryngofissure is the operation of choice and in properly selected cases the final results are most satisfactory. Border line cases are frequently seen which tax the diagnostic acumen of the surgeon. Persistent hoarseness over a period of time, gradually becoming worse, conveys to the mind a picture of an extensive lesion. Definite fixation of a cord with an extensive growth is a positive indication that conservative surgical procedures advocated heretofore will be of no avail. Radical surgery, such as laryngectomy, will offer some hope provided there has been no extension of the growth outside the laryngeal box. Conservatism when dealing with cases of carcinoma of the larynx must be disregarded and the surgery suited to the particular case instituted. I am convinced that when dealing with carcinoma of the larynx, it is better to err on the side of radicalism than conservatism.

While deep roentgen-ray therapy is now available and offers splendid results in some cases, the uncertainty of the outcome is such as to make me most skeptical. My cases receive one or two therapeutic doses of deep x-ray for fixation of the cells in mitosis just prior to operation. I am firmly convinced that surgery is the method of choice when dealing with carcinoma of the larynx, that x-ray therapy may be used as a valuable adjunct, and that these 2 methods should be used together when the occasion demands.

It is truly appalling to realize the large number of advanced cases of malignancies that are consulting the laryngologist for the first time. Too frequently these cases have progressed beyond the stage where surgical intervention will offer any hope of cure. Deep x-ray therapy can likewise offer little hope in these advanced cases. How are we to account for the delay of the patient

find thymic enlargements, foreign bodies, trauma, and, probably the greatest offender, papilloma of the larynx. The occurrence of multiple papilloma of the larynx in children is a most distressing condition. These growths are benign in character and may spring from any portion of the larynx. They are, however, frequently considered as malignant in so far as they recur repeatedly. I know of no condition occurring in that delicately arranged and highly organized voice box, with the possible exception of stenosis of the larynx, which requires more patience, perseverance, and careful surgery than do cases of multiple papilloma. In the removal of benign tumors great care and caution must be exercised not to injure or traumatize normal tissue. This is of the greatest importance when dealing with papilloma of the larynx because papilloma are autografting and will spring from any new raw surface created hence the necessity for the utmost care in the handling of these cases. Despite careful and painstaking removal of the growths, many cases recur repeatedly. I cannot as yet foretell when a patient is first seen whether or not the condition will respond promptly to treatment or whether repeated removals of the growth will be necessary in order to effect a cure.

The milder types of growth improve remarkably and after 2 or 3 roentgen ray exposures or the surgical removal of the growths the throat is free of papilloma. The other type comprises those cases in which every known method is used unsuccessfully to eradicate the growth. You can realize more clearly the obstinacy and persistence of recurrence of multiple papillomas when I tell you that 2 of my patients have baffled all attempts at eradication of the growth. One was first seen at the age of 4 with extensive multiple papilloma. Repeated removals of the growth were unsuccessful in preventing recurrences and extensions. At the age of 14 he developed multiple lung abscesses and died. At this time papilloma completely filled the laryngeal surface of the epiglottis, filled and overflowed the larynx, extended into the subglottic region and involved the trachea to within a short distance of the bifurcation. The other patient was first seen at the age of 3 with extensive papilloma which continued to recur as fast as removed. The early use of radium produced a stenosis of the esophagus. A second gastrostomy at the age of 20 was followed by complications and death. At this time the papillomatous mass was most extensive partially blocking the mouth of the esophagus, filling the larynx and protruding through the neck externally in the region of the larynx. Microscopical

examination of the growth showed a malignant degeneration of the papilloma. These 2 cases are briefly mentioned to show that all cases of papilloma do not clear up spontaneously at puberty. Some progress in spite of all efforts and even develop into malignancies.

Benign growths occurring in the larynx are responsible for alteration in vocal production. I have been fortunate in obtaining views of various growths occurring in the larynx such as vocal nodules, contact ulcers, single and multiple papilloma, hematomas, angiomas, fibromas, cysts, and granulomas, showing distinctly how they interfere with accurate approximation, thereby producing varying degrees of hoarseness. Benign lesions present the problem of accurate removal with as little trauma to normal tissue as possible. Delicacy in the handling of laryngeal tissue is amply repaid by little or no reaction following surgical removal of small tumors. The accurate and thorough removal of benign lesions practically assures no recurrence of the original growth except in those cases of multiple papilloma which recur repeatedly and may well be classified as potentially malignant.

Hoarseness as I have stated before, is nature's first signal of distress, and a laryngeal examination will give important information. Traumatism, foreign bodies, gumma, tumors of the thorax, aneurism, and enlarged thyroid glands may be productive of hoarseness. Occasionally a partial or complete paralysis of one vocal cord may be present, due to an enlarged thyroid, with practically no alteration of voice. In the event a thyroidectomy is contemplated in such a case, a pre operative examination may save the surgeon much embarrassment. For many years I have been associated with a service in a general hospital in which every patient subjected to thyroidectomy has a pre operative and postoperative examination of the larynx. The wisdom and value of such an examination are obvious.

In my experience tuberculosis of the larynx is always secondary to an infection in the pulmonary tract. The pulmonary process may not be sufficiently active to cause the patient any concern and the laryngeal involvement represents latent activity. Here early diagnosis is of vital importance.

The favorite site for tuberculous lesions of the larynx is within the interarytenoid space. Pain is a constant factor in advanced cases of tuberculous laryngitis. Syphilis may likewise affect the larynx in any of its various stages and often presents problems in the differential diagnosis, even to the laryngologist. Diseases of

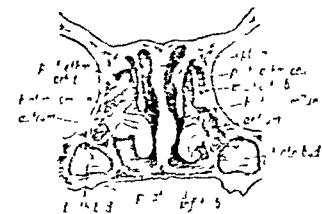


Fig 1

Fig 1 Coronal section of a newborn child showing the comparative size of the tooth buds and of the maxillary antrum

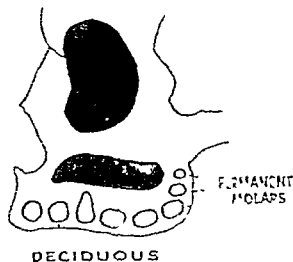


Fig 2

Fig 2 Diagrammatic drawing of the position of the deciduous teeth buds and the germ centers of the permanent molars at 5 months

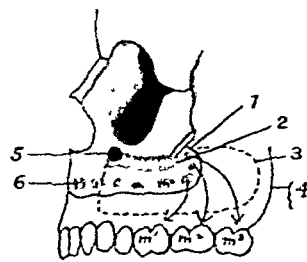


Fig 3

Fig 3 The influence of the development of the antrum on the rupture of the upper teeth. The shaded area is of an infantile superior maxilla with its antrum, which, as it develops, forces the permanent upper molar teeth into their normal position (Keith). When the normal antrum develops, the three molars are in contact with its floor.

The forcing of teeth, roots, or diseased bone into the antrum contaminates the sinus, which, as a rule, is already inflamed, with the result of producing an empyema. An acute antrum associated with a swelling of the cheek is suggestive of dental origin.

INCIDENT

Gordon Berry in two interesting reports read before the 1928 and 1929 meetings of the American Laryngological Association gave his impression of the frequency of the relationship between diseased teeth and maxillary sinusitis. His private cases showed 20 per cent of the acute and 80 per cent of the chronic maxillary sinus infections to be of dental origin.

In reviewing the case histories of 32 radical antrum operations done on our private patients during the past 16 months, 2 were the results of malignancies, 2 followed fractures obtained in automobile accidents, 7 had dental fistulas following extraction of teeth; 9 had chronic hypertrophic membranes or empyemas as a part of a pansinusitis; 12 of the antra contained 1 or more polyps of which 6 were considered of dental origin because of the site of their attachment. The other 6 cases of polypoidosis required bilateral antrum operations.

Infection of the sinuses in children is seldom of dental origin, the exception being the rare cases of osteomyelitis originating about the teeth of infants. In one such instance (Case 1), G. G., male, aged 4 months, was seen in consultation with Dr. E. C. Ellett for an or-

bitary cellulitis. A stab wound through the lower lid made by a surgeon in a neighboring town was unproductive of drainage. Examination and roentgenological study revealed an acute purulent maxillary sinusitis. At operation an osteomyelitis of the upper jaw was found and the child lost its 2 upper molar tooth buds. The older the patient under consideration with a maxillary sinusitis, the more likely will it be that dental infections play an important part as a causative factor.

DENTAL CYST

Dental cysts are more frequent than diagnosed, as they may present no characteristic sign or symptom and usually are accidentally encountered while raying the sinuses. If there is any suspicion of a dental cyst its presence can be proved by filling the antrum with a radiopaque oil and again roentgenographing the sinus.

a. *Radicular* (root, dental, or periodontal) cysts are the result of chronic inflammation of the periodontal membrane, usually associated with infected pulpless teeth. A typical example may be found about the upper lateral incisor, as the thickness of the cancellous bone in this region readily allows of cystic formation. All granulomas do not mature into cysts due to the lack of the cellular constituents essential to their development. These cysts may continue their growth after the removal of the offending tooth. They seldom cross the median line and their progress is outward,

in seeking medical aid in these advanced cases of malignancies? Can it be because the patient fails to realize the significance of persistent hoarseness, or has the general practitioner ignored the danger signal of the larynx? The importance of voice changes must be more fully appreciated and the

co-operation of the general practitioner solicited in an effort to direct these cases to competent laryngologists for examination and diagnosis. The importance of an early diagnosis must be stressed in all cases of hoarseness if we are to be successful in our fight against carcinoma of the larynx.

INFECTIONS OF THE PARANASAL SINUSES OF DENTAL ORIGIN

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THE wonderful improvement in sinus patients following a clean up of their dental pathology is an indication of the close relationship between the infection of the paranasal sinuses and the teeth. The maxillary is the sinus most frequently infected by extension from the teeth. The ethmoidal cells can be infected secondarily by extension from the antrum, and in one of our cases a tooth was found within the ethmoidal labyrinth, acting as a foreign body. The frontal sinuses in turn may be blocked by the former sinuses and at times a slowly ascending purulent infection will produce a pansinusitis of one side from a dental infection. It is important in all cases of maxillary sinusitis that the teeth be carefully examined and studied roentgenologically.

There is a close relationship between the teeth and the maxillary sinus. The deciduous teeth have their nativity in the cancellous bone below the antrum, and at birth the bud of a deciduous molar is larger than the cavity of the antrum. At 5 months the bone behind the antrum contains the invisible germ centers of the permanent upper molars, one stacked upon the other. As the antrum pneumatizes, it extends backward and downward pushing before it the alveolar process containing the tooth buds. If the natural pneumatization of the antrum occurs, the upper molars are rotated into their normal position, the first at 6 years of age, the second at 12, and the third or wisdom teeth after the 18th year.

The antrum continues to increase in size throughout life, the increase in the latter years being due to the thinning of the bony walls. The exception to this natural law is when the development of the antrum is arrested during the formative period as the result of one severe infection or the accumulated action of repeated mild infections or allergy (vasomotor rhinitis and sinusitis), or when the removal of all the upper teeth allows a recession of the outer angle of the antrum due to the absorption of the alveolar process. Should pneumatization be excessive, the roots of the molars are more prominent within the antrum and the forward extension contacts the cuspid and rarely the incisors.

MAXILLARY SINUS

The maxillary sinus may be infected directly by either acute or chronic infections of the teeth immediately adjacent to the sinus or indirectly because of a lowered resistance as the result of dental infections. The direct extension occurs from periapical or periodontal disease, which produces within the sinus either an inflammatory reaction or a direct contamination. Dental insults account for a number of acute empyemas of the antrum, as when in doing an extraction a passage is made through an infected socket into the antrum. At times the incomplete hygiene of a socket will leave roots or decayed bone, which serves as an insidious focus, and as a starting point from which occurs an ascending infection. Traumatism may play a part and leave fractures through which infection may enter the sinus.



Fig 5



Fig 6.



Fig. 7.

Fig 5. Roentgenogram of the skull showing a dental polyp outlined by the instillation of a radiopaque oil into the antrum.

Fig 6 Side view showing a dental polyp outlined by the instillation of a radiopaque oil into the antrum.

Fig 7. Roentgenogram showing a follicular cyst.

plastic procedures may be required for the repair of the surgical damage.

CUSPID AND INCISORS

When the pneumatization of the antrum is excessive, it will have a direct relationship with the upper cuspid, and in still rarer cases, the incisors. Periodontal infections about the upper cuspid and incisors will produce a swelling of the structures in the vestibule of the nose and an extension of an osteomyelitis may involve the septum.

CASE 3 A G was admitted to the Baptist Hospital in the middle of the night with an intense pain deep in the face. Two weeks previously he had experienced the removal of his upper teeth. The day after the extraction of the incisors, his upper lip began to swell and a throbbing pain developed within the nose, each night the pain demanded a sedative and on the night of admission, the pain became so severe that the medication was unsuccessful in relieving the suffering. The dental wounds were healing normally, but upon examination of the nose, the septum was found to be swollen. A roentgenological study revealed an increased density of the bony septum. Sulfanilamide treatment was begun and intranasal tampons were inserted every 4 hours for 20 minutes, during which time infra-red therapy was applied over the face. An abscess of the septum developed, which, on drainage, relieved the headache. The patient made an uneventful recovery.

ETHMOIDAL SINUS

Prolonged infection within the antrum will extend to the ethmoidal cells and in turn the blockage of the frontal duct by the anterior cells will produce a frontal sinusitis. Fortunately, early attention to the maxillary sinus disease will prevent the ethmoids and frontals from becoming chronic.

CASE 4 Recently a woman, L. B., aged 43, at operation had an undeveloped cuspid free within the anterior ethmoidal cells. This patient was first seen following an automobile accident at which time a deformity of the nose was corrected. Eighteen months later she returned with a history that she was not satisfied with a negative diagnosis as to the cause of a right sided headache, given her at one of our larger eastern hospitals. Examination and roentgenological study revealed a pansinusitis of the right side. Nasal treatments relieved the pain, especially if the right antrum were irrigated through the ostium. A radiopaque oil instilled into the antrum brought out in the roentgenological study that the membrane lining the antrum was uniformly thickened. An exploratory opening of this antrum discovered a diseased lining membrane, and after the agger nasi cell was opened, an undeveloped cuspid tooth was extracted. There is no way of ruling out that this tooth was not in its present location at the time of her accident, but the spacing of her teeth confirmed the opinion that the tooth had never migrated to its normal position. Studying the original roentgenogram made at the time of her accident, the shadow



Fig 4 Photomicrograph of a button biopsy demonstration of the pathology of the lining membrane in a case of an emptyema of the antrum of dental origin

eventually into the vestibule of the nose or the anterior end of the antrum. They grow slowly and with little pain and their presence is detected because of a bulging outward of the alveolar plate, the diagnosis being confirmed by a roentgenogram. These cysts must be differentiated from the median anterior maxillary cysts.

Treatment consists in the removal of the teeth bordering the cyst and surgical dissection of the cyst wall, the wound being allowed to heal openly by granulations. If the cyst has migrated into the antrum the latter should be opened and inspected. Should the antral membrane be diseased a radical operation is demanded but if the membrane appears healthy, a nasoantral window for drainage will be sufficient. I have watched the migration backward of a cyst from the region of the upper lateral incisor through the pyramidal process of the superior maxilla into the antrum. In its progress it devitalized the adjacent canine and first bicuspid.

b *Follicular cysts* (dentigerous) are less frequent than radicular cysts, being of develop-

mental origin, the result of proliferation and degeneration of the cells of the enamel organ connected with an unerupted tooth, the latter being included within the cyst. They occur at any age, but most frequently during the second dentition. The unerupted tooth, acting as a foreign body, stimulates the misplaced anlage to unlawful growth. The cuspids, incisors, and third molars are the most frequent offenders in either the upper or lower jaw. Histologically, they are surrounded by a fibrous capsule lined with squamous epithelium. The cyst consists of a cavity filled with a fluid and contains a part or the whole of a tooth. The teeth usually involved are permanent or supernumerary.

I have seen one follicular cyst in a child of 4 (Case 2), the condition being diagnosed as sarcoma of the superior maxilla but during an attempt to fill the antrum with a radiopaque oil, the cyst was entered and the oil replaced the contents of the cyst.

Because of their constant growth without pain, the condition is usually diagnosed as a tumor, the significant diagnostic point is the absence of a permanent tooth in the region of the swelling. A roentgenological study will confirm the diagnosis and the treatment is similar to the manner of handling a radicular cyst.

c *Adamantinoma* (multilocular) are rare benign tumors arising from dental epithelium. Histologically, they consist of irregular masses of epithelial cells surrounded by a fibrous stroma with a definite capsule. The tumor readily undergoes cystic degeneration, and the diagnosis is made because of the deformity produced, the absence of pain and signs of inflammation differentiate it from an active infection. At times the tumor may grow rapidly and by pressure destroy vital teeth.

The treatment is surgical and the larger tumors may leave deformities requiring plastic repair.

d *Dermoid cysts* are congenital accidents containing characteristically dermoid structures, such as hair, teeth, and the glands of the skin. Those found in the antrum originate in the hard palate and are diagnosed by their size and roentgenological peculiarities. Their treatment is surgical, and like adamantinoma

CASE 6 J. F. M. A dental surgeon misread a dental film and attempted to remove on the wrong side an unerupted upper third molar. The operation ended with a large opening through the posterior wall of the maxillary sinus and a strip of gauze packing was fitted into the wound. When the patient reported the next day, there was no gauze visible and an attempt to probe and irrigate the antrum for it was futile. There developed a pansinusitis of that side, which aggravated the old gentleman's arthritis. A radical antrum operation was necessary to remove the strip of gauze which was located high in the antrum.

CLOSURE OF DENTAL APERTURE INTO THE ANTRUM

The openings left after extractions vary from root size to massive injury. It is difficult to close a circular aperture the walls of which are bone, but if the canal made by the aperture is converted into a trough it will readily heal. This requires the removal of the outer wall of the canal and a sufficiency of the anterior wall of the antrum to allow the sliding down of a mucous flap, which is sutured in place with black silk. A removable dental appliance made with flanges is utilized to protect the healing wound until a permanent bridge is made.

FRACTURES OF THE MAXILLA INVOLVING THE TEETH

The sudden and permanent stopping of fast moving automobiles and aeroplanes throws the passengers forward with great force, striking their faces against protruding objects, usually on the dash board. The injuries sustained by the superior maxilla vary from simple, depressed fractures to crushing injuries in which all of the teeth contacting the sinus have been jammed into it. There is no set

rule of handling these accidents, but no teeth possessing attachments should be sacrificed at the emergency operation. The bony fragments of the hard palate and the walls of the antrum should be replaced and the teeth given mechanical support. Many will be saved and those lost will have served in preserving the contour of the alveolar process.

INTRA-ANTRAL TEETH

Unerupted teeth that migrate into the antrum will act as foreign bodies within the sinus, and should be removed.

CASE 7. C. W. R. sought relief from a chronic maxillary sinusitis. Roentgenological study showed the antrum involved contained 3 fully developed teeth within its cavity. The first molar had rotated its position and the crown faced upward into the antral cavity.

These intra-antral teeth sooner or later die and become foreign bodies and their removal is demanded.

FATAL COMPLICATIONS

An osteomyelitis of the superior maxilla following an extraction performed in the face of an active infection may prove fatal, either rapidly by causing a cavernous sinus thrombosis or insidiously as the result of a spreading osteomyelitis.

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Fig 8 Follicular cyst lipiodol injection

cast by the tooth was always behind the nasal process of the superior maxilla and could be read into the plate only with the foreknowledge of its presence.

MANAGEMENT OF ACCIDENTAL PERFORATION OF THE ANTRUM

When a tooth penetrates the antrum at its extraction, the socket and dental sinus should be thoroughly cleansed and left alone. A procedure of watchful waiting should be instituted, and if the antrum succumbs to the infection, the sinus should be opened through the nose. There is no excuse for tinkering with an antrum through an unnatural dental opening, and a dentist guilty of maintaining an alveolar opening into an antrum should be condemned. At times, a piece or a whole root will slip into the maxillary sinus during an extraction. When this occurs simple means should be tried to deliver it through the opening, but if simple measures fail, a window should be made through the anterior antral wall, and the foreign body removed. This is very simple when done by an experienced surgeon.

There is a tendency for the dentist to curette his perforation, and often an aperture remains which is so large that its closure requires a plastic operation.

The dentist is relieved of any liability of an antral infection, following a dental penetra-



Fig 9 Case 7 Roentgenogram demonstrating three molar teeth within the antrum and one at the angle of the lower jaw.

tion, if he immediately refers the patient to a competent rhinologist, and does not interfere with the antrum. The question of legal liability is solved, for the patient cannot successfully sue the dentist for penetrating the antrum, but if the dentist continues to treat him he (the dentist) may be liable for not doing what "the state of the art" demands. I once recovered from an antrum a piece of wooden applicator broken off in the antrum in an attempt by a doctor to replace a polyp protruding through a dental opening. Fortunately, the same individual was the patient and the doctor.

CASE 5 W L R Dr Justin D Towner while removing the first upper molar discovered that the anterior buccal root penetrated into the antrum. He immediately referred the patient and upon examination and roentgenological study the antrum was found to be infected with the ostium closed which accounted for the absence of nasal discharge. Two years previously a radical antrum operation was performed on the other antrum of this gentleman because of a neglected nasal condition following a similar dental complication. An antral nasal window was made into which a No. 16 F rubber catheter was inserted as a drain. The discharge was very offensive and to clear the antrum permanganate potash 1:4000 solution was instilled through the tube into the antrum frequently for 2 days. Under this treatment the fistula healed and the patient escaped the fate of his former experience.

DANGERS OF PACKING A DENTAL FISTULA

When a dentist penetrates an antrum he should avoid extensive curetting of the fistula tract and above all never insert any packing capable of slipping into the antrum.

There has, however, in this brief span of years been an astonishing advance in the requirements for admission to schools and their number has been reduced from 162 to 67 approved four to six year schools. It is generally recognized that "the undergraduate course of study can only begin the education of the physician, for he must remain a student all his life" if he is properly to fulfil his obligations

"A widespread and permanent improvement in the quality of medical service cannot be secured until graduate medical education has been developed at least to the level of excellence of the better undergraduate courses."

This desideratum is being approached in certain of the specialties which have organized national boards to establish the qualifications of the individual to practice a specialty and to make public those so qualified. Such a board in surgery has been established. We may justly hope that it will do much to improve the situation. If present plans mature the College will be in a position to give invaluable co-operation.

This scheme is in keeping with an objective long held by the College. Indirectly, it will as time goes on improve the professional attainments of our fellowship for in most cases it will constitute a hurdle which the aspirant will have taken successfully before entrance into the College. But it is not proposed that the College shall in any sense abrogate its right to determine the fitness of the candidates for its own membership. Special consideration must be given to attributes difficult to ascertain by the methods so far set up by these Boards, such as judgment, integrity, and personal fitness.

The American Board of Surgery representing the various surgical organizations of the country proposes to initiate or expand in numerous properly equipped hospitals the training for several years of the graduate student under intimate control and instruction. This would constitute an apprentice type of experience and should embrace the fundamental sciences of anatomy, physiology, pathology, as well as the history of surgery.

The College has gone on record as whole heartedly supporting this enterprise. A Committee on the Graduate Training for Surgery

appointed by the Board of Regents reported in October, 1935. This whole question is so important and is so little understood that it seems well to summarize this report which has contributed to important developments in surgical education.

The discussion was confined to the period in the development of a surgeon between the acquisition of his medical degree and his qualification as a surgeon; this may be termed the graduate phase as distinguished from the undergraduate and postgraduate. It was felt that intensive training involving much actual experience and responsibility and further study in anatomy, physiology, and pathology as related to surgery would most satisfactorily lead to the development of qualified surgeons. The required opportunities and facilities for such training exist only in a very limited number of teaching hospitals associated with schools of medicine. It was, therefore, recommended that non-teaching hospitals with proper personnel, plant, and organization be encouraged to undertake graduate training for surgery and that the College establish a minimum standard requisite for the approval by the College of such hospitals for training surgeons.

The report was approved and the committee was authorized to co-operate with committees of other surgical organizations in the development of a program in accordance with the tenor of this report.

But even when the young man with the background and training prescribed by the Board of Surgery launches upon his own, he cannot be considered a perfected product.

"In this broad earth of ours,
Amid the measureless grossness and the slag,
Enclosed and safe within its central heart,
Nestles the seed perfection."

Walt Whitman

Much in years and labor is required to smelt the slag and to free the seed of perfection from its enveloping husk of measureless grossness.

Hippocrates realized this in stating poetically, "Such, in effect, as is the culture of plants, is the study of medicine. Our natural disposition is the soil; the precepts of our masters are the seed; instruction, begun from

THE 1937 CLINICAL CONGRESS

THE COLLEGE AND THE CULTURAL ASPECTS OF SURGERY

EUGENE H. POOL, M.D., F.A.C.S., New York, New York

ON November 15, 1912, it was voted that a College of Surgeons be organized. Peculiar significance, therefore, attaches itself to this meeting by reason of the fact that it is the quarter century mark in the history of this College.

The general objective of its founders was the elevation of the standard of surgery by means of the following specific measures:

1. Development of a comprehensive association to enable visiting surgeons to see surgical confreres at work and to discuss with them problems of practical surgery.

2. Enrollment of competent and ethical surgeons.

3. Opposition to the barter in patients by fee splitting.

4. Protection of the public from incompetent, dishonest and unnecessary surgery.

5. Improvement of hospitals and teaching institutions.

Notable progress has been made toward these goals. But it has not always been smooth going. There have been stumblings and uncertainties, criticisms and contests. Yet the College has survived and now holds an important place in and exerts a salutary influence upon American surgery. Its accomplishments and activities need not be reviewed save in so far as they suggest questions of policy for the present and future.

Surgical education looms up as the most important problem at the present time. In analyzing it we find four phases:

1. The making of the man.

2. The making of the doctor—undergraduate education.

3. His training and qualifications for specialization in surgery—graduate training.

4. The final step in the making of a surgeon—postgraduate study.

Address of the Returning President presented before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.

Let us keep these phases in mind during our discussion.

Cutler states that "the real education of the surgeon is a postgraduate affair." But this is true only in part. It overlooks the all important period of development which I have called "the making of the man." The importance of this has been appreciated throughout the ages. To quote Horace, "A cask will long retain the flavor with which, when new, it was impregnated." And Kipling epitomizes the thought in opening his autobiography: "Give me the first six years of a child's life," he says, "and you can have the rest." It is the early formative years that have the greatest influence upon character formation.

That something is wrong with our system of education is emphasized by the words of notable contemporaneous educators. Sir Alfred T. Davies says, "We have so systematized our education that it has lost its soul. Intellectual curiosity has been destroyed and independence of character has been sacrificed for cleverness." And President Butler writes, "We must get rid of the notion that education is identical with instruction and that preparation for making a living is on the same plane as preparation for life."

We shall, however, pass over these inferences and direct our thoughts to medical education with special emphasis upon the preparation and qualifications to practice surgery. Thirty-five years ago "only 20 states had any requirements of general education whatever and only 10 of these required graduation from a high school. No state demanded any college training preliminary to the medical course which in many schools at that time was only three years in length."

A man with such meager preparation was legally entitled to undertake major surgery.

Wills, J. C. R. *People's Current trend in medical education*. New York: State J. Med. 1935; 30: 1930-1942.

Among our 12,000 members mistakes have been made. This is past history. It takes time to develop a plan of certification. This is still being developed and each year the procedure is becoming more and more efficient. I venture to predict that in a very few years the decisions of the Credentials Committees throughout the land will meet with universal approval. Let me in this connection call to your attention a recent ruling in regard to the requirements for fellowship in the College.

Applicants for fellowship whose qualifying medical degree shall have been obtained after the date of January 1, 1938, shall be required to present evidence of having completed three years of hospital service in one or more hospitals approved by the American College of Surgeons for graduate training in surgery, of which two years shall have been spent in training in surgery. In the case of graduates of medical schools which withhold the medical degree until after a fifth year of hospital internship, the date set will be January 1, 1939.

In the development of modern surgery technical aspects progressed by notable stages. Speed was at first exploited. James R. Wood¹ effected a thigh amputation in 9 seconds. Then came the anatomical era, represented by such men as Frank Hartley. Each structure was carefully and laboriously outlined by sharp dissection. Halsted's example of prolonged meticulous dissection, careful asepsis and thorough hemostasis probably made the greatest impression on the surgery of today. Technique is now relatively standardized in two schools: one, silk and slow; one, absorbable material and measurable speed. Both insist upon the essential features, careful sharp dissection, hemostasis, asepsis and the minimum of irritating foreign bodies. It is no longer the technical but the mental supremacy that makes the great surgeon. It is the head, not the hand. Besides those general qualities which we have outlined, the competent surgeon must, besides clinical experience, have knowledge of pathology, physiology, general medicine, and psychiatry. Centuries ago it was said, "Only he who in himself unites medicine and surgery is a perfect physician."

The physician who knows only one branch is like a bird with only one wing." As to psychiatry, Bard remarked over 100 years ago, "The physician who confines his attention to the body knows not the extent of his art. If he knows not how to soothe the irritation of a troubled and enfeebled mind, to calm the fretfulness of impatience, to rouse the courage of the timid, and even to quiet the compunctions of an over-tender conscience, it will very much confine the efficacy of his prescriptions; and these he cannot do, without he gain the confidence, esteem and even the love of his patients."

Culture and industry and constant study are essential. Rappleye tersely and idealistically summarizes the motives of our present education. "After all," he says, "the purpose of a medical training, broadly conceived, is to prepare a cultured and educated gentleman and not merely a technician."

To return to common sense; one must treat the patient, not the disease.

Can anything be more ill advised than to tell a 75 year old clergyman, whose only pleasure is smoking, that he must give it up because a small patch of leucoplacia may develop into cancer? This was done by an eminent specialist. The patient was advised otherwise and is still smoking at the age of 85.

Or can anything be more foolish than a six hour operation for advanced carcinoma of the breast on a woman of 79? In such instances the surgeon follows a rule of thumb method and does not consider the interest of the patient. He fails to grasp the all important axiom of Hippocrates, "to do good and to do no harm."

Suggestions are heard that something should be done to meet the urge of the medical man for a participation in the surgeon's fee. In other words a compromise. One reads, "First, the economic maladjustment in medicine makes it imperative for the man in general practice to indulge in fee splitting or else it would not be as prevalent as it is. Second, organized medicine will never get anywhere by condemning the practice but must offer something constructive in its place." There should no more be a compromise in regard to this, than there should be a compromise with

¹Bradshaw, J. H., James Rushmore Wood. Surg., Gynec. & Obst., 1929, 48: 447.

childhood, is the sowing of the seed in proper season, the place where instruction is given is the surrounding air where the plants find their nourishment, diligent study is the hand of the workman, finally, time strengthens and brings all to maturity."

Graduate study must continue throughout life. In the past, opportunity for this has been largely restricted to foreign lands.

Even centuries ago students journeyed to Bologna, Padua, and Salerno. Through Lanfranchi the Italian influence was injected into France. It was even then taught that "no one can be a good physician who knows nothing of surgical operations, and no one can operate who does not know medicine." It was through the universities at this period that the teaching of medicine was systematized and received its stimulus toward modern efficiency and graduate opportunity. During much of the 19th century English and Scotch students went to Paris, but later to Berlin and Vienna, which offered rich hospital and laboratory facilities. Our forebears, beginning with Morton and Bard, received their inspiration largely in the mentioned foreign centers.

But the child has grown apace and surgery in America is now on a plane so high that we are no longer dependent to an appreciable degree upon outside resources for purposes of surgical training. Indeed the tide has turned and students from afar are coming to us in progressively increasing numbers. Technical developments and influences from all sources have been garnered and culled in the clinics of our country and the simplified net results have been transmitted to the individual surgeons throughout the land. There is now no excuse for a man who has had opportunity to do a reasonable amount of surgery to do poor surgery. In his early years, however, he may well be a menace if left to his own devices, uncontrolled and without supervision. A large number, moreover, will always be mediocre, merely technicians. How he can be controlled and how more men can be lifted above mediocrity are problems for this College.

What is it that makes the great surgeon? To answer this one naturally attempts to analyze the characteristics of the masters

with whom he has come in contact rather than those who have been analyzed and dissected by others. The outstanding and invariable quality has been that uncommon virtue termed common sense. Bull, Peck, McBurney, Richardson, Judd, to mention a few only, had a certain something best termed a nice judgment. This quality is a gift from God and such men would probably have been equally competent in other walks of life. Such a man rarely gets himself or his patient into avoidable trouble and rarely makes unwise decisions.

Humanity and kindness come next, which lead such men to think primarily and dominantly of their patient's welfare. John Hunter had these qualities to a supreme degree. Common sense, modesty, kindness and charity. Crabtree states "His works were simply announced as by John Hunter. A plain door plate, with the same name, announced his residence. Money was a secondary consideration to him. To a poor tradesman from whom he had received 20 guineas for performing a surgical operation upon his wife, he returned 19 guineas, having learned with what difficulty and extreme self denial the husband had raised the money. 'I sent back 10 guineas and kept the 20th,' he said, in apology for retaining even the one, that they might not be hurt with an idea of too great an obligation."

Next, resourcefulness and courage but never rashness that is, the ability to meet without loss of nerve unexpected and serious conditions sometimes of his own making.

Technical skill and a scientific training are a *sine qua non* but are inadequate without the above attributes. Technique allows skillful routine work but alone it marks the artisan, not the surgeon.

These traits cannot be taught, they are God given.

Since the College cannot altogether change the type of man, extreme care must be taken to exclude the incompetent and the male factor and to admit only those of ability and sterling character. "Only men who have given proof of their competency should be entitled to public recognition and trust as surgeons."

NOTES ON 1937 MEETING

BOWMAN C. CROWELL, M.D., Chicago, Illinois

THE annual Clinical Congress ranks among the major educational activities of the American College of Surgeons, and the 1937 Congress in Chicago had the most able form of assistance from the Chicago surgeons in providing a worthy educational program in clinical surgery. Under the guidance of Drs. Vernon C. David and Michael L. Mason, a much appreciated reorganization of the arrangement of the surgical clinics was instituted so that a continuous clinical program in general surgery and each of the surgical specialties was provided. This arrangement made it possible for each Fellow in attendance at the Congress readily to find worthwhile clinics in the subjects of his special interest on each day. Overcrowding of the clinics was in a large degree obviated by precautions which had been taken by the committee on arrangements in cooperation with the hospital administrators.

The scientific meetings in general surgery and surgery of the eye, ear, nose and throat, which were held in the afternoons and evenings at headquarters, supplemented the purely clinical programs in the hospitals and covered many subjects of current surgical interest. The symposia on the subjects of cancer, fractures, and traumatic surgery continued to hold the interest of the audiences, and the attendance served to illustrate the great current importance generally attached to these subjects to which committees of the College are devoting much time and constructive effort. The reports furnished by these committees reflected a satisfactory progress in their work.

A symposium on graduate training for surgery, participated in by representatives of other organizations, served to emphasize the importance of such special training for surgeons and to crystallize the present trend of organization for such a purpose. It is expected that more and more hospitals will organize their work and otherwise equip themselves so that an increasing number of residencies for

graduate training in surgery may be available.

At this Congress the Presidential Meeting and Convocation were combined on the evening of the first day. Following the installation of the new officers, the approved candidates were accepted into fellowship and thus were able to attend the other meetings of the Congress as Fellows. These candidates had assembled at College headquarters during the afternoon where a recapitulation of College activities and the significance of active fellowship were presented by officers of the College. This assembly was followed by a social hour during which an opportunity was furnished for the candidates and their families to become familiar with the home of their College.

Another series of meetings was held at College headquarters on Wednesday morning when there were assembled the Judiciary, Credentials, and local Executive Committees. Officers of the College explained the functions of these committees, and an informal discussion of their duties and responsibilities ensued in the course of which methods for accomplishment of their purposes were elucidated. The beneficial effects of these assemblies were the subject of much favorable comment by Fellows during and after the Congress.

The almost continuous projection of motion pictures on surgical subjects was a feature of the Congress that attracted large audiences and again emphasized the educational advantage of this medium. Preliminary review at the College of all films shown at Congresses serves to insure a high type of motion picture programs and these seem to be appreciated if the volume of the attendance can be taken as an index of real interest.

No review of a Clinical Congress would be complete without mention of the important conferences and demonstrations on Hospital Standardization, but these are being reviewed separately.

Lay education on medical and hospital subjects was carried on during the meeting

the man who kidnaps a child. The professional abortionist is less objectionable, to my mind, than the man who splits fees. While he is breaking his Hippocratic oath, he at least is doing something which he conceives to be right and for the welfare of the patient.

To the fee splitter may be applied the words of Hippocrates, "So false a judgment seems to me to depend principally upon this—that the profession of medicine is the only one that is subject to no restriction or punishment, except disgrace, now, disgrace does not wound those who live by it."

The College is taking active and aggressive measures to eliminate the fee splitter and to clean up hospitals which are nests for these vultures.

Its Judiciary Committees and the Board of Regents have been particularly active during recent years in investigating and penalizing hospitals and individuals who have been found guilty of fee splitting and other breaches of ethics. There is a Judiciary Committee for every state and province, to which all questions of personal ethics dealing with Fellows of the College are submitted for investigation and report to the Regents. The mere knowledge of the existence of such a committee, with power to investigate and make recommendation, has had a very salutary effect in regulating local situations, and the plan in operation enables the College to act intelligently in dealing with undesirable Fellows, or situations which involve candidates or institutions.

The Clinical Congresses have become so successful that the clinics are often not able to accommodate the number who wish to attend. The Sectional Meetings which are miniature Clinical Congresses, five of which are held each year, will probably relieve this embarrassing situation.

Probably no activity of the College has been more effective and more productive of results than hospital standardization. It is distinctly an educational project and has affected profoundly the members of the hos-

pital staffs. If the plans of the Board of Surgery materialize, such standardization will be an essential link in the chain.

We have discussed the five points which were enumerated as the purposes of the founders of this College. At this quarter century mark are there not other objectives to which the energies and resources of the College might be directed?

The historical aspects of surgery call for clear definition and statement. The College, through its Fellows and as an organization, should bring its influence to bear upon the young aspirants in surgery. It is a fault common to many organizations of "higher learning" that they more largely affect those who have "arrived" than those who are "on the way." The student in surgery, undergraduate as well as graduate, should be taught the history as well as the techniques, et cetera, of surgical practice. The College, by means of fellowships, prizes and awards, might well encourage the pursuit of the cultural aspects of surgery among the younger men.

The College is qualified to serve in the crystallization and guardianship of the highest and best traditions in surgery, which call for a continuous reiteration and restatement of the ideals of surgery and of the surgeon. In this commercial age it is especially important that conscious efforts be made to encourage ideals, develop character, and support the highest professional standards. I have read the addresses of our former presidents and am much impressed not only by the number of distinguished men who have occupied this office but by the high ideals expressed by them as to the functions and future of this College. To be included in the list is an honor for which I thank you. I realize how inadequately I have filled the office. One is bound to make comparison with such a one as our late and much lamented president, Robert Greenough, who labored for the College with such sound and impartial judgment that he will ever live in its history as a shining inspiration and outstanding example.

TWENTY YEARS OF HOSPITAL STANDARDIZATION

MALCOLM T. MacEACHERN, M.D., Chicago, Illinois

THE Twentieth Annual Hospital Standardization Conference held in Chicago in connection with the Clinical Congress of the American College of Surgeons demonstrated a sustained interest in the hospital program which has been carried on by the College during the past twenty years

The addresses, papers, discussions, and demonstrations were highly interesting and instructive. There were two especially significant aspects of the meeting. One of these was the participation in the program by representatives from other leading national medical and hospital associations—the American Medical Association, the American Hospital Association, the American College of Physicians, the Canadian Medical Association, and the American College of Hospital Administrators. Each of these organizations has its special interest in the administrative, educational, or professional functions of the hospital. All of these subjects are embraced in the comprehensive program of the College which is concerned with continuing improvement in the institutional care of the sick and injured.

The other outstanding evidence of individual and group interest in a common problem was the intimate discussion of hospital service in conferences in which physicians, trustees, hospital executives and personnel were jointly concerned. It augurs well for the future care of the sick when the interests of various individuals and organized groups can be harmonized in this manner, thus giving greater momentum to the endeavor to promote better care of the patient.

There was the customary interest in the announcement of the list of approved hospitals for 1937, based on the twentieth annual survey. Twenty years ago, in 1918, only 89 hospitals merited approval by the College. This year 2,621 hospitals were awarded full or provisional approval. While the increase in the number of approved hospitals in the last decade has not been spectacular, it has been

steady and substantial. Actually, the progress of this work cannot be measured by the number of new hospitals added to the approved list, but rather by the raising of the entire level of hospital service. Once a hospital meets the Minimum Standard for Hospitals, it is expected to press forward to ever higher attainments. It can be said of Hospital Standardization that it is far from static in its influence, since hospitals approved years ago continue to show notable advances from year to year, and the rate of progress is accelerated by the growing appreciation of the advantages of united effort under this program.

Because of the emphasis which is being given to professional education as it affects the hospital personnel today, a number of discussions in the hospital conferences were devoted to this subject. Nurses, medical social workers, dietitians, technicians, and medical record librarians must meet definite standards of education and training in order to maintain present-day standards of service. The medical staff is involved in the trend toward stricter basic standards of preparation for all services of the hospital which are related to diagnosis and therapy.

Graduate training for general surgery and the surgical specialties, as well as for medicine and the medical specialties is, therefore, a live topic today. It was agreed at the conference that the facilities of non-university connected hospitals would have to be utilized to provide the necessary further opportunities for graduate training. The surgical staffs of many hospitals are already taking active steps to establish definite standards of qualifications for those who wish to do major surgery. In one large city where there are a number of approved hospitals a definite standard for major surgery has been agreed upon. This is a trend in the right direction, but training and experience should be the basic consideration. Every well organized, approved hospital, with adequate personnel and facilities, should actively support any legitimate move to promote

through the press and radio and at a community health meeting. The co operation of the representatives of the press and radio with the local committee on public relations was cordial and effective.

The scientific and technical exhibits reached a proportion not previously attained by the Congress, and each served a valuable educational purpose.

Scientific exhibits which were prepared by the College were supplemented by those of individuals and of other national organizations which are engaged in work which has a direct bearing on the work of the College in its Departments of Hospital Standardization and Clinical Research. Many of the technical

exhibits demonstrated the modern trend of such exhibits in presenting material of a direct educational nature.

Each year more and more surgeons from foreign shores are paying American surgery the compliment of attendance at our Clinical Congresses and this year the list of foreign visitors was a long and distinguished one. An honorary fellowship was conferred upon Mr. J. P. Lockhart Mummery of London who delivered the annual oration on surgery on the subject "The Surgeon as a Biologist."

Chicago surgeons and hospitals are to be congratulated on the excellent program provided and they merit the thanks of the American surgical profession.

OBSTETRICS AND GYNECOLOGY

RADICAL OBSTETRICS AND NATIONAL MATERNAL MORTALITY

FRANK W. LYNCH, M D., F.A.C.S., San Francisco, California

THE practice of medicine has undergone remarkable changes in recent years. Discoveries in biochemistry and other fundamental sciences have broadened our understanding of disease. Improved methods of anesthesia and operative technique have opened up new fields for surgery and have caused drastic changes in treatment of many diseases. Naturally there have been developed strongly conservative and radical schools. Yet in no branch of medicine are the two schools farther apart in indications for surgical treatment than they are in obstetrics today. The ultraconservative view that the average labor could be entrusted to an experienced nurse or midwife as is done in many countries has never been favored here either by our women or by physicians, even though the latter undertook the prenatal care, repaired the lacerations, and took care of the complications which ensued. Rightly or wrongly, there is a gradual elimination of the midwife in nearly all sections of the country.

On the other hand, the radical school feels that childbirth in the hands of nature is too crude to fit in with the ideas of modern life. Led by a small but active group of well trained obstetricians, they are doing what they can to alter it. Much surgery has followed in consequence, and we are in the midst of a furor of operative obstetrics. A number of different groups of physicians have been attracted to the movement. All of them have surgical aspirations but few of them have had much practical experience in obstetrics. As a group they see the new movement chiefly as a new field for surgery. Indeed some of them limit their obstetric practice to patients whom they themselves select for cesarean section. On the other hand, there is a large group of experienced practitioners who are becoming more radical, not because of convictions but because they find it both expensive and foolish to swim against the tide.

While many reasons are given for this radical movement, the most important one is woman's

insistence for childbirth without pain. Brought up from infancy on the lay propaganda of twilight sleep, and with the achievements of modern medicine spread before her almost daily in the lay press, she reasons logically from the evidence put before her by untrained lay women that, in this day of scientific medicine and surgery, the risk in childbirth must be trivial indeed. She cannot be blamed for accepting unhesitatingly any method of delivery which promises a living child and which is conducted under anesthesia or deep analgesia.

The modern school of radicalism in obstetrics started with effort to restrict pain, because it has been known for ages that man cannot improve a labor which is progressing normally except to reduce pain. With the routine use of analgesia and anesthesia for the entire period of labor came an unusual amount of uterine inertia requiring operative interference. Then followed attempts to shorten labor by instrumental or operative delivery under anesthesia. Untrained men soon learned that mid-forceps, high forceps, and version can be very difficult operations with very sharp and narrow indications and definite contra-indications and that primary cesarean section is much easier for them to perform. As a result, in various parts of the country today, labors are precipitated by the artificial rupture of the membranes, conducted under heavy analgesia and anesthesia, terminated by low forceps, version, or cesarean section almost as routine.

This is not the time to argue the theoretic merits or demerits of marked radicalism in obstetrics, nor to review the credo of those who see pregnancy as a 9 month disease, nor to discuss whether labor is a normal or abnormal process because it is attended by severe pain, tearing of tissues, and the death of thousands of women and their infants each year, nor to comment on the fact that in these days of wars, strikes, unemployment, and high taxes the arguments aforementioned for radicalism seem trivial indeed. Nature in the raw is seldom kind. There were 12,544 maternal deaths in the United States in 1935. Yet, ten thousand persons were killed last year by homicide. Eight times more people will be killed by automobiles

From the Department of Obstetrics and Gynecology, University of California Medical School

Presented in the Symposium on Obstetrics and Gynecology before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937

graduate training in general surgery and the surgical specialties

A notable feature of the hospital standardization program this year was the attention given to the departments within the hospital which are related to oral surgery, psychiatry, physical therapy, pharmacy, medical social service, and others. The discussions emphasized the need for good organization and efficient supervision and control of these services which are so closely related to the rapidly advancing interest in improved methods of diagnosis and therapy.

Medical staff conferences received a due share of attention, it being generally believed that although frequently medical staff conferences are far from ideal, because of the sensitiveness displayed by some staff members, nevertheless this important practice in approved hospitals has been rapidly improving both in frequency and in quality of the discussions. Approximately 50,000 medical staff conferences were held in 1937 as compared with a possible 5,000 twenty years ago.

To a small degree this provides an estimate of the great benefits which are conferred both upon the patients and the members of the medical staff through the wider acceptance of such conferences, the success of which naturally depends upon positive and enthusiastic leadership. The conduct of the medical staff conference formed the basis of a demonstration at one of the sessions.

The hospital conference revealed that in many instances, the making and keeping of medical records is still a weak point in hospital work although in general a great advance is noted. Medical staffs would do well to evaluate the quality of their medical records through frequent tests of usage for group

studies and the writing of papers. The late Dr. John B. Murphy kept excellent medical records. He asserted that, given a record which was properly written and of good quality, in ninety cases out of a hundred a reasonably accurate diagnosis of the disease or condition could be made without seeing the patient. Complete medical records reflect the scientific spirit of the medical staff, the care and precision with which they do their work, the progressiveness of the medical profession of the community, and the sincerity of purpose of the institution as a whole.

Emphasis was placed upon the desirability of achieving the objective, "an accredited pathologist for every approved hospital," and the importance of continued progress in the practice of radiological diagnosis and therapy. In the latter field the disturbance over economic status should not be permitted to retard the advancement of this science.

All of the discussions in this year's hospital standardization conference appeared to culminate in one idea which in the past was not always emphasized: the patient must not be regarded merely as an organism with a heart, lungs, kidneys and other vital organs, without due recognition of the fact that he is a human being and not a number, and that he has a distinct personality and many idiosyncrasies. The new idea in hospital service is to treat the patient as a whole and to recognize the interrelation of physical organs and functions and the inseparability of these from the patient's mental and emotional characteristics. It is an exceedingly serious responsibility that the modern hospital must assume if it is to measure up to its full possibilities in the advancement of medical science and in its service to humanity.



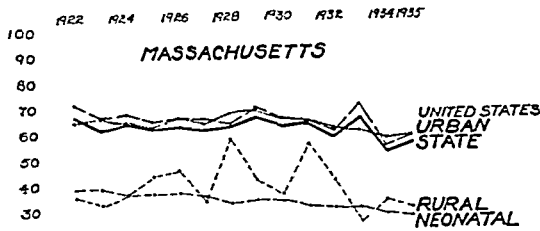


Fig. 3 Trend of maternal mortality in Massachusetts

graduate instruction The American College of Surgeons has done a great service by insisting upon staff meetings, mortality studies, proper diagnostic equipment, separate units for maternity cases, and consultation for obstetric complications in hospitals which it certifies. The problem cannot be solved by such means, however, because of the large number of hospitals which will always fall short of the requirements for certification and never come under the definite control of any of our present medical organizations. Yet these hospitals will continue to admit obstetric cases.

The Federal Government through its Children's Bureau is acting with the various state boards of health to enable our medical organizations to give refresher courses to practitioners in their local communities. Courses of this type, however, can never be other than elemental nor accomplish more than to help develop a proper background. The formation of the American Board of Obstetrics has done much to create interest in more extensive obstetrical training. While these various movements sometime will make it difficult for the untrained obstetrician to practice radical obstetrics with the approval of his fellow physicians, it may take many years before this desired result will be attained. What is urgently needed at present are more institutions in which the young graduate can work as an apprentice and receive adequate practical instruction.

Medical schools can never be expected to train all of their students as surgeons or obstetricians. They are equipped to give only the groundwork of any branch of medicine. It is true that undergraduate obstetric education is constantly improving. The teaching of obstetrics and gynecology by the same instructors has marked a great advance. Yet no amount of classwork, laboratory courses, moving pictures of operation, and manikin exercises can train the student to pass directly from the classroom to care for other than a perfectly normal obstetric case. After the theory must come much apprentice work before the student learns judgment and technical skill. Yet

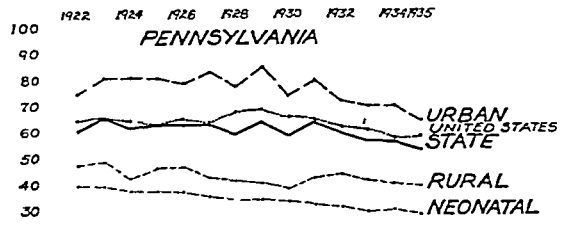


Fig. 4. Trend of maternal mortality in Pennsylvania

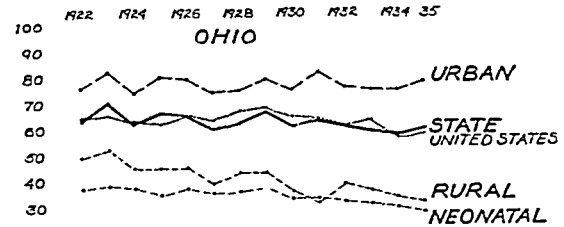


Fig. 5 Trend of maternal mortality in Ohio

(These graphs were compiled from material furnished by the Children's Bureau of the United States Department of Labor.)

state boards of medical examiners do not demand evidence of adequate practical training as prerequisite for their examinations.

There are very few institutions in America where a young graduate can receive even one year's training—the minimum time in which one may obtain a working knowledge of obstetrics provided, of course, that there is adequate instruction and supervision. The *Journal of the American Medical Association* lists but 82 approved hospitals admitting more than 1,000 patients annually which offer residencies in obstetrics or obstetrics and gynecology. Only 62 of this number offer both resident and assistant resident positions. Altogether there are only 287 positions listed which offer a minimum of even one year's experience in obstetrics, including all approved hospitals, even those with less than 1,000 admissions per annum. When we reflect that approximately 5,000 students graduate yearly in medicine, we see that few of them can receive obstetric training. Comparatively few students can obtain even the sketchy obstetric training given in a rotating hospital service of a month or two of obstetrics or in the three or four months of home delivery service. Yet this lack of practical experience prevents comparatively few graduates from undertaking any type of obstetric work in their first year of practice. Indeed, many of them will join the radical school in spite of the fact that they have not had obstetric training. If we are to beat this trend, we must develop more well staffed maternity and

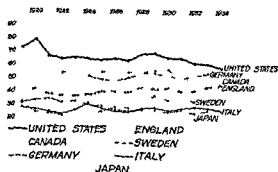


Fig 1 Trend of maternal mortality in the United States and certain foreign countries. Deaths assigned to pregnancy and childbirth per 100 000 live births

this year than will die in labor, and statistics of life insurance companies show that women live longer than men. It is proper, however, to discuss what the movement actually has accomplished and how we can alter it if present results are not satisfactory.

When we attempt to review what the movement has accomplished, we are confronted with the fact that it has not reduced maternal mortality. Had it done so, there could be no argument about its value, because no one questions the merit of its aims. Yet the maternal mortality rate of the nation and of nearly all of our most populous states, has remained fairly constant during the years radicalism in obstetrics has been developing so rapidly. There has been a slight reduction in the rate due to improved public health conditions (Figs 1, 2, 3, 4, 5). But the mortality rate due to septicemia has shown no reduction. Moreover in some centers the maternal death rate actually has risen because the deaths which are termed 'preventable' are increasing faster than the 'non preventable' deaths are decreasing.

Nor does it appear likely that the maternal mortality rate will be reduced in the near future if the results of radical obstetrics continue as they have in the recent past. Last year I cited to the Clinical Congress of the American College of Surgeons essential facts of cesarean section as reported in the largest series of cases in our literature since 1930. The incidence was 7.5 per cent in 524,117 births (12,055 cases) with a surgical mortality of 4.1 per cent. This high mortality assumed added importance because cesarean section was responsible for one fourth of all the maternal deaths after the seventh month of pregnancy in the areas covered by this report.

The well trained radicals insist that it is unfair to judge the movement by maternal mortality figures because most deaths occurred in the practice



Fig 2 Trend of maternal mortality in New York

of untrained men. Nor do they feel responsible because such men join the movement and under take obstetric operations that they have not been trained to do. That almost every known type of specialist in medicine undertakes major obstetrics is shown in all recent mortality reports. In final analysis however, it is evident that he who is not interested in radicalism or conservatism in obstetrics must look directly at results. The facts are that the maternal mortality rates in this country have been too high, suffer in comparison with those of other countries, and have not been properly reduced. The improvements in operative technique and preparation and after care of the patient which have lowered operative mortality rates in surgery have failed thus far to do the same in obstetrics. Maternal mortality rates may not interest the untrained obstetrician but they vitally interest the Federal Government. In these days when the normal increase in population is being retarded by voluntary birth control a national mortality rate unduly high demands the very serious consideration of a medical profession that is not anxious to participate in state medicine.

It is evident that the new school of obstetrics needs proper molding by the control of the men and the procedures which are causing a high maternal and fetal mortality. At first sight the task seems Herculean because radicalism has developed in the face of active opposition of nearly every leading teacher of obstetrics. Yet the movement can be combatted by creating the sentiment in the profession that only well qualified obstetricians should be allowed to undertake major obstetric surgery. Conditions in obstetrics are no worse than they were in surgery 25 years ago when the American College of Surgeons began its task of educating the American surgeon. Education rather than legislation will solve the problem. Fortunately, the profession is becoming more and more interested in higher medical education.

Many agencies are doing what they can to improve the obstetric education of the physician, working chiefly through some type of brief post

solution is taken, the excess fluid is eliminated very slowly within 24 to 48 hours. If water is taken before the consumption of food, it will be eliminated rapidly. However, if taken after the consumption of food, it will be retained and stored with the food until the food becomes oxidized.

Positive water balance The intake of water may exceed the output, in which case a positive water balance will be established. This may be due to an excessive consumption of fluid, or to an interference with the output. Pathological changes which interfere with normal kidney function may result in a positive water balance. This fluid may accumulate in the intracellular spaces, producing a visible edema, or it may become bound in the cell protoplasm, in which case little or no evidence of edema is apparent. Muscles can store a considerable amount of intercellular water. Normally half the body water is held within the muscles. The retention of fluids can be most easily elicited by a visible or palpable edema or by an abnormally rapid gain in weight.

Pregnancy normally is characterized by a positive water balance. This retention of water is most marked in the last half of the gestation. The generalized tendency to edema in pregnant women may be the cause or the effect of this positive water balance.

The fetus may be regarded as a fast growing tissue of the mother's body consuming considerable water. The placenta likewise enlarges rapidly leading to marked retention of fluid. The turnover of water may be correspondingly large, so that the total water requirement of the mother may become disproportionate to the surface area.

This permanent increased fluid supply, cellular and intracellular in character, is evidenced by the ease with which edema develops late in pregnancy. The blood volume gradually increases so that at term the total volume averages 23 per cent greater than in the non-pregnant individual. This blood volume increase is a blood dilution, for the increase in the hemoglobin and the cellular constituents does not keep pace with the increase in the blood plasma. This altered fluid metabolism of normal pregnancy necessary for both the growing fetus and the preparation for labor can be easily upset and result in pathological complications of serious import. An increased positive water balance is thus a characteristic finding in most of the late toxemias of pregnancy. A decreased blood volume with a concentration of the cellular constituents is associated with severe pre-eclampsia and eclampsia.

In this discussion the endocrine influence on water balance has not been considered. Numerous

experiments indicate that the posterior lobe of the pituitary gland exercises an important function in water metabolism. There is no doubt that this function becomes of even greater importance in pregnancy. The physiological hypertrophy of the pituitary gland may be the cause of this increased function. Dieckmann and Michel have demonstrated that the parenteral injection of extracts of the posterior lobe of the pituitary gland in patients with pre-eclampsia or eclampsia will produce a decrease in volume of urine, an increase in the chloride concentration, and a rise of blood pressure. These significant findings indicate the rôle of this gland in normal pregnancy and particularly in the toxemias of pregnancy.

The effect of the adrenal glands on water metabolism in pregnancy is likewise little understood. We know, however, that these glands influence the metabolism of sodium chloride and therefore play an important rôle in water balance. Just how these facts concern themselves with pregnancy toxemias is not known, but certainly chloride balance and water balance are intimately associated.

Negative water balance Negative water balance results when the available supply of water to the body diminishes below normal levels, either as a result of decreased intake or because of an interference with gastro-intestinal absorption. Thus, starvation, vomiting, and diarrhea result in an interference with the fluid intake. There may be an excessive loss of water so that the normal balance cannot be maintained. This may be due to hemorrhage, loss of fluid from serosal surfaces, or damaged skin (burns, blisters). It may result from excessive loss due to sweat, saliva, fistulas, etc. There may be increased output by way of the kidneys such as in diabetes mellitus or insipidus.

Dehydration is first manifested by an increased thirst. It is characterized by a shrinkage of the subcutaneous tissues, a dry, hard, leathery skin, a decreasing urinary output, rapid loss of weight, anhydration fever, and a retention of acid radicals resulting in an acidosis. In severe cases of dehydration there is a decrease in the blood volume, with a resultant increase in hemoglobin, cell volume, serum protein, and non-protein nitrogen.

Hyperemesis gravidarum is chiefly characterized by a negative water balance. In this condition the water consumption may be normal but the available supply to the body tissues is decreased because of the continued vomiting. All the symptoms and findings of dehydration appear, depending upon the severity of the condition. The successful treatment depends, to a large extent, on the re-establishment of a normal water balance.

obstetric wards in well managed general hospitals so that more men yearly can receive adequate practical training. Moreover, the American College of Surgeons by constant effort finally must make it as difficult for the untrained man to do

major obstetrics in approved hospitals as it has made it for an untrained surgeon to do major surgery. The profession should not permit its members to learn practical obstetrics entirely from private patients.

WATER BALANCE IN RELATION TO TOXEMIAS OF PREGNANCY

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WATER is the chief constituent of all body tissues. It accounts for approximately 65 per cent of the total body weight. It is necessary to all physiological functions. As a vehicle or as a solvent it conveys to the body cells all the materials necessary for life and carries off the waste products of normal metabolism. Water is present in the body in two forms. It may be intimately bound in the cell protoplasm, bound water, or it may be present in the intracellular spaces, free water. When demands are made upon the supply of water in the body the intercellular fluid is readily available and is consumed first, after which the cells give up their bound water. Cellular fluid is contained largely within the muscle cells. An excess is not easily discernible so the body can add an appreciable amount to this store without noticeable evidence of the increase. However, when extracellular water increases considerably in amount it manifests itself readily as edema.

Water balance. Normally the body maintains a balance of water by regulating the output to the intake. Thus the output increases with an increased intake and diminishes when the intake decreases. Adolph has estimated that the average sized man uses approximately 3,400 cubic centimeters of water per square meter in 4 hours. This water is supplied to the body by the liquids consumed and by the various foods which vary in their water content. The metabolism of an average mixed meal of 3,000 calories furnishes 300 grams of water, but as the meal is consumed at the table it contains approximately 2,000 cubic centimeters of water.

The output of water occurs largely by way of

the kidneys but a considerable amount is lost by the lungs (300 cubic centimeters), by the skin in the sensible way or sweat (200 to 400 cubic centimeters) and in the insensible way (1 cm^2) and by way of the alimentary canal (100 cubic centimeters). These latter routes lose varying amounts depending on temperature, humidity and muscular activity.

The circulation serves as a distribution system for the body fluids. Ingested water is rapidly made available to all the body cells and the excess disposed of through the outgoing channels. Despite this rapid interchange of fluids the blood volume remains remarkably constant for an individual.

A rapid and serious drop in blood volume such as takes place in hemorrhage is quickly compensated by an increase in plasma volume through the passage of fluids and serum protein from the tissue spaces into the circulation. The increase in plasma volume persists until new hemoglobin is produced. Marked reductions in blood volume are associated with a marked increase in the plasma constituents hemoglobin, cell volume and plasma proteins. This hemoconcentration is present in serious disorders associated with an abnormal water balance. Pre-eclampsia and eclampsia may exhibit blood concentration and a reduction in blood volume.

When water is consumed a slight blood dilution occurs. The excess fluid is stored in the tissues and perhaps in newly opened capillaries. With an increased urinary excretion this accumulated fluid is gradually eliminated. The water that is drunk is usually excreted in the urine within 2 or 3 hours. The insensible loss of water increases in amount so the body usually ends up with somewhat less water than before the ingestion of the fluid. The same result is obtained by drinking an isomolar salt solution. On the other hand if sodium chloride

From the Department of Obstetrics and Gynecology, The University of Chicago and The Chicago Lying-in Hospital.
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cells, so that the output of chlorides in the urine diminishes. These trends are aided by a gradual loss of plasma volume from the circulation containing electrolytes and serum protein.

Following delivery this blood concentration rapidly disappears. As the blood dilutes, water, electrolytes, and serum protein pass from the tissues into the blood stream. Once this reversal takes place, it is rapidly accelerated until the normal balance between circulation and tissues again is restored. The failure of this dilution to take place in the toxemias of pregnancy is a finding of great import, for it usually heralds a grave prognosis. One can, therefore, follow the course of the blood concentration as an important prognostic aid in the treatment of pre-eclampsia and eclampsia.

TREATMENT OF PRE-ECLAMPSIA AND ECLAMPSIA

In the treatment of these toxemias, the normal restoration of water balance is of prime importance. Theoretically, this can usually be accomplished by diminishing the intake of fluids and increasing the output. Arnold and Fay have developed a therapeutic regimen which consists of a limitation of fluid intake below the fluid output and an increase of the output by a rapid dehydration of the patient through purgation, spinal fluid drainage, the intravenous use of hypertonic glucose solutions, and the intravenous use of magnesium sulphate. These authors thus make use of all the avenues of fluid loss by the body, except bleeding. They report excellent results.

The treatment of these toxemias at the Chicago Lying-in Hospital likewise emphasizes the importance of establishing a normal water balance. To accomplish this, however, the intake of fluids is rarely restricted beyond normal requirements. The loss of excessive body fluids is encouraged by cutting down the salt intake to negligible amounts, thereby favoring a shift of fluid balance from the tissues to the blood stream. The change in sodium balance is followed by a change in water balance so that an increased fluid elimination takes place. When diet and the elimination of salt intake fail to accomplish an increased loss of body fluids and sodium chloride, hypertonic glucose solutions are used to establish an adequate diuresis, thus increasing the output of fluids by the kidneys. Once a reversal of water balance is initiated, the process continues with increasing speed.

When hypertonic glucose solution is introduced into the circulation, the resultant increased osmotic pressure draws fluids into the circulation. The glucose passing into the tissues replaces the sodium chloride in the cells and this chloride finds

its way into the circulation. Chemical studies indicate that glucose actually replaces serum chloride. The loss of chlorides from the tissues into the circulation likewise results in the loss of tissue fluid. The increasing blood volume produced by this mechanism results in an increased urinary output, together with a marked increase of chlorides in that urinary output. The use of hypertonic glucose solutions, therefore, aids in breaking up the vicious circle which has resulted from the increasing positive water balance. The continued intravenous use of hypertonic glucose solution tends ultimately to restore a normal water balance. Practically, the successful dilution of the blood by this means is a reliable index of the success of the therapy. Failure to produce dilution of the blood by increasingly more concentrated solutions indicates the severity of the toxemia.

If an individual is given 500 cubic centimeters of a 20 per cent glucose solution intravenously within a period of 30 minutes, a prompt and satisfactory diuresis occurs. A more marked reaction takes place when 30 per cent hypertonic solutions are used and even a better response when 50 per cent solutions are used. However, when more than 200 grams of glucose are given rapidly, there is a very marked glycosuria. It has been found that the more sugar that is spilled in the urine, the less toxic material is excreted. In the treatment of the toxemias of pregnancy, therefore, it seems logical to use 20 per cent solutions unless the volume of fluid injected into the circulation is dangerous to the patient because of a damaged cardiovascular system.

Where hypertonic glucose solutions have failed to cause a blood dilution and produce a satisfactory diuresis, acacia has been suggested and used. This substance occasionally succeeds in producing a diuresis when glucose solutions have failed. However, its use is not without danger as severe reactions have been reported.

It has been demonstrated that the intravenous administration of hypertonic glucose solutions dilates the capillaries in the fingernail bed. Thus, it may serve to exert a favorable influence in the toxemias of pregnancy, particularly the convulsive type, in which vessel spasm may be an important factor in the causation of the convulsions. The dilatation of the capillaries in the kidney results in an increased blood supply with its concomitant increased urinary excretion.

TREATMENT OF NON-CONVULSIVE TOXEMIA

Prophylactic. The careful observation of the woman during pregnancy at frequent intervals offers the best safeguard against the development

The toxemias of pregnancy are a heterogeneous group of complications incidental to pregnancy. Hyperemesis gravidarum, which is usually grouped with the toxemias has nothing in common with the late toxemias. However, in a discussion of water balance it is well to include this condition for the present treatment of this complication concerns itself largely with the restoration of normal fluid balance.

The classification of the late toxemias of pregnancy has been the subject of much discussion in recent years. There has been a general tendency toward the simplification of this classification. At the present time the toxemias can be grouped under the following headings: pre-eclampsia and eclampsia, essential hypertension, vascular renal disease, nephritis and nephrosis. Although there is a disturbed water balance in all of these toxemias, nevertheless we are concerned chiefly with pre-eclampsia and eclampsia. It is here that the most marked variations in fluid metabolism occur. It is here too that the proper approach to the treatment offers the best results.

We are just finishing an epoch in the treatment of the late toxemias of pregnancy wherein the surgical termination of gestation was the most important principle in the treatment. It was felt that the termination of pregnancy offered the one certain means of influencing the course of the disease since the exact etiology of these conditions is unknown. The end of the gestation will usually influence favorably the course of a toxemia, but the surgical manipulations necessary for this termination may prove extremely detrimental to the best interests of the patient. Cesarean section is probably the most dangerous method of treating eclampsia for it carries with it an extremely high maternal mortality. A large number of statistics have accumulated to show that operative intervention in eclampsia, particularly cesarean section, offers the worst prognosis for the patient in a serious condition. Furthermore in the treatment of pre-eclampsia, operative intervention likewise is a more dangerous procedure than treatment by medical means which is followed if necessary, by the induction of labor by simple procedures. The high maternal mortality in the toxemias of pregnancy as well as in cesarean section is probably due to the high incidence of operative interference. It thus becomes necessary to understand the underlying basic principles in the medical treatment of these conditions in order to decrease the high incidence of operative interference.

The late toxemias of pregnancy—pre-eclampsia, and eclampsia—are characterized by a marked disturbance of water balance. The normal pos-

sitive water balance of pregnancy probably contributes to the ease with which a pathological water balance develops. Clinically the earliest manifestation of pre-eclampsia may be the sudden gain in weight. Whenever a patient gains 3 or 4 kilograms in a week or 10 days one must assume that this increased weight represents to a large extent an increased water storage. Edema may or may not be present, depending upon whether this fluid is largely intercellular or extracellular.

With the retention of water there occurs a retention and storage of chlorides for tissues can not store water in the absence of sufficient chlorides. The blood chlorides however fail to increase in amount even during the convulsive state, for a balance is always maintained between the blood chlorides and the tissue chlorides. This increased chloride content of the body tissues represents, therefore, an increased intake and retention of chlorides rather than a decrease in the chloride output.

If one now carefully estimates the intake and the output of fluids, the increasing positive water balance is readily detected. The urinary output which accounts for a considerable amount of the fluid lost, gradually diminishes. The urine chlorides likewise diminish in amount. In the pre-eclamptic stage just prior to the convulsive seizure the output of urine may decrease tremendously and with the onset of the convulsions an actual anuria may set in. This sudden elimination of the most important avenue of fluid output must be ushered in as a result of vessel spasm in the extensive capillary beds. This vascular constriction may be the final contributing factor in the production of the convulsive stage.

Dieckmann and his associates have demonstrated that pre-eclampsia and eclampsia are likewise characterized by changes in the blood volume. When the clinical symptoms of hypertension, albuminuria and edema become marked a decrease in the blood volume begins to take place. This decreased blood volume is best noted by the concentration of the blood constituents, thus the serum protein, hemoglobin and cell volume increase in amount by the passage of water containing electrolytes, glucose and non-protein nitrogen into the patient's tissues. A very small diminution of blood volume is present in normal pregnancy at the onset of labor but in the toxemias of pregnancy this reduction is very marked. This hemoconcentration adds to the disturbed water balance which already exists. The intracellular and extracellular water is greatly increased in amount. There is a marked increase in the storage of chlorides in the tissue spaces and

should always favor termination. When the baby is at the borderline of viability, there is a tendency to continue medical treatment as long as possible.

In general, the induction of labor should be as simple as possible. Medical induction supplemented by the simple rupture of the membranes usually suffices at or near term. In some cases the insertion of a small hydrostatic bag into the cervix is necessary to start labor. Cesarean section should be considered but rarely and usually only in the event that there is another indication in addition to the toxemia. It should always be done under local anesthesia.

TREATMENT OF CONVULSIVE TOXEMIA

General. The constant observation of the patient with frequent determinations of the temperature, pulse, respiration, and blood pressure is extremely important. External stimuli should be eliminated as much as possible for they tend to start the convulsions.

Sedation. The convulsions can be controlled by a number of sedatives. Morphine sulphate is probably the most effective drug. It can be given in doses of $\frac{1}{4}$ grain every hour until the convulsions cease or the respirations decrease to 12 per minute. Luminal-sodium, 5 grains every 8 to 12 hours, can be given subcutaneously. If magnesium sulphate is used its administration should be limited to intramuscular injection. Ten cubic centimeters of a 25 per cent solution can be given after each convulsion.

Water balance. A careful check on the urinary output is absolutely necessary in the conduct of eclampsia. A retention catheter should be placed in the bladder so that all the urine can be collected. The intravenous injections of 500 to 1000 cubic centimeters of a 20 per cent solution of glucose administered in 40 to 60 minutes can be given 2 or 3 times daily to promote a diuresis. If a satisfactory response is not obtained from this concentration, a 30 per cent glucose solution can be used. Sufficient glucose should be administered to insure a urinary volume of at least 30 cubic centimeters per hour.

Termination of the gestation. When the convulsions have been brought under control and a satisfactory urinary output has been established by the intravenous administration of hypertonic

glucose solutions, the interruption of pregnancy can be considered. The rupture of membranes usually suffices to initiate labor. Where the cervix is long and uneffaced, the insertion of a small bag into the uterus aids in the induction of labor. Cesarean section is *almost never indicated*. This operation should be performed only in the event that a cephalopelvic disproportion exists.

Diet. Nothing is given by mouth until the patient is conscious. The patient can then be fed through a nasal tube, starting with 50 cubic centimeters of a 10 per cent solution of karo syrup and increasing by 50 cubic centimeters per hour until a total of 200 cubic centimeters per hour is reached. The total intake and output of fluids should be carefully checked until the clinical findings improve.

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of serious toxemia. At the Chicago Lying in Hospital the incidence of toxemia is about 7 per cent but only rarely does a case of convulsive toxemia develop among the patients under observation. Adequate prenatal care should include a close check on the patient's weight gain, in addition to blood pressure determinations and urine analysis. Clinically, the earliest manifestation of a developing toxemia may be an unusually rapid weight gain which is indicative of a disturbed water balance with its fluid and sodium chloride retention. Edema may or may not be present at this time. The average weight gain of a group of normal women during pregnancy was 21 pounds contrasted with a gain of 44 pounds for women who developed toxemias of pregnancy. The weight gain is distributed in such a way that the patient has no increase in her weight at the end of the first trimester that she gains a half pound per week during the second trimester and a pound per week during the last 3 months. Whenever a patient has a weight increase of 6 or 8 pounds in a period of a week or 2, one must assume this sudden increment represents largely increased water storage. Prompt treatment tending to restoration of a more normal water balance should be instituted.

Mild cases—ambulatory treatment—rest. The patient should be encouraged to secure at least 10 hours of sleep nightly. In addition she should rest for an hour or two morning and afternoon. She may be nervous, irritable, and unable to secure proper rest in which case phenobarbital $\frac{1}{2}$ to $1\frac{1}{2}$ grains 2 or 3 times daily may serve as a sedative. It may be necessary to rearrange her household responsibilities before she can secure the desired rest.

Diet. This should consist largely of carbohydrates and a limited amount of proteins. It should be *salt poor*. If the excessive weight gain is not due entirely to water retention, fats should be omitted from the diet. A maintenance diet of a quart of milk, eggs, some meat, unlimited fruits and vegetables can be used for a prolonged period without detriment to the patient.

Water balance. The trend of the fluid balance can be ascertained by carefully noting the weight and by measuring the intake and output of fluids. A loss in weight which continues over several days or longer denotes a loss of tissue fluid and a tendency toward the restoration of a more normal water balance. This is likewise indicated by a urinary output which exceeds the fluid intake. The edema should disappear. The return of a more normal water balance should be reflected in a decrease of the blood pressure and a diminution in the albuminuria.

Severe cases—hospital treatment—rest. If the patient fails to improve under management in the home, hospitalization is usually indicated when this is possible. The patient should now have complete bed rest, preferably in a quiet environment. Phenobarbital $1\frac{1}{2}$ grains 3 times daily or luminal sodium 5 grains subcutaneously, once or twice daily, can be used as a sedative.

Diet. The diet should be as *salt poor* as possible. It should consist of fruits, vegetables, eggs, cereal, toast, tea or coffee. If the toxemia is very severe in character, the diet should be restricted largely to fruits, vegetables and fruit juices but this limited diet should not be maintained longer than a week or 10 days.

Water balance. The water balance should be determined by measuring the intake and output of all fluids. The output of fluids should exceed the intake until all evidence of edema and the excessive weight gain have disappeared, after which they should balance.

The restoration of a more normal balance is aided by increasing the fluid output through the use of hypertonic glucose solutions. The rapid (30 to 40 minutes) intravenous injection of 500 cubic centimeters of 20 per cent glucose solution 2 or 3 times daily usually provokes a diuresis and increases the fluid output. It may be necessary to use a 30 per cent solution to obtain a satisfactory urinary response. If there is evidence of cardiac decompensation the fluid intake should be limited and 100 to 200 cubic centimeters of a 50 per cent solution should be used. The intravenous fluids can be continued as long as necessary to maintain a satisfactory urinary output.

Termination of the gestation. The termination of the pregnancy offers the one certain way of altering the course of the toxemia. Delivery usually results in blood dilution, increased urinary output, rapid loss of chlorides and a change toward a normal water balance with subsequent improvement in the patient's clinical condition. It is important therefore to initiate labor before the onset of the convulsive phase and before irreparable damage to the patient ensues.

The pregnancy should be terminated (a) if the patient's symptoms and findings fail to improve under treatment, (b) if cerebral, visual or gastrointestinal symptoms develop, (c) if jaundice develops, (d) in the presence of cardiovascular impairment, (e) if a favorable water balance cannot be produced because of a persistent oliguria or anuria or because of an increasing blood concentration. In the presence of a viable baby at or near term the question of terminating the gestation is not difficult to decide, and the decision

manipulation of the nerves of Frankenhaeser's plexus which causes the patient to groan, even under deep anesthesia, at the time of clamping the cervical supports during a vaginal hysterectomy.

Essential dysmenorrhea has become a topic of greater interest since recognition that it may be a cramping of the uterine musculature ascribable to an excess of the estrogenic factor, opposed by the corpus luteum hormone. Endocrine therapy has not yet been proved to be of distinct value in relief of this affection, but the future is promising.

I have been slow to accept resection of the superior hypogastric plexus (the presacral nerve) as the procedure of choice in cases of intractable essential dysmenorrhea. We have resorted to nerve resection over a period of many years, but chiefly in selected cases in which other pathology required surgical intervention. Gradually the number of cases has grown and some operations have been performed for the sole purpose of presacral nerve resection. My records indicate that not a single patient has failed to obtain relief. Nevertheless, I still look upon this operation as an important undertaking, to be resorted to only in intractable cases after other measures prove futile.

Nerve blocking by means of alcohol injection in the region of Frankenhaeser's plexus was advocated by Bloss in 1929 for the relief of dysmenorrhea and other deep-seated pelvic pain. The procedure as employed by the vaginal route has not become widely popular and some instances of necrosis and inflammatory reaction have been recorded.

Acquired dysmenorrhea. Particular emphasis should be accorded the part played by uterine obstructions in the causation of pelvic pain, but the subject of obstruction is an important topic which we may well pause to consider. Obstructed drainage from the uterus is quite as serious as is inadequate drainage from other regions of the body, and in these days of radium therapy and cauterizations and amputations of the cervix, interference with the free flow of menstrual blood and uterine secretions is encountered almost daily in the practice of a busy gynecologist. The pain of obstructed uterine drainage varies from ill-defined pelvic discomfort to severe cramps, accompanied by inadequate or prolonged menstruation, a dark or tarry flow is characteristic but not pathognomonic, for a dark flow also occurs with disturbed ovarian function. Employment of a fine Hegar dilator verifies the diagnosis, although the evidence may be inconclusive without confirmation under anesthesia.

If my individual experience is a criterion, it will eventually be regarded as a surgical error to use radium, or make repeated endocervical topical applications, or apply the cautery within the cervical canal, or amputate the cervix of the uterus, or even administer expectant care to a patient with notable endocervical disease, without prolonged and attentive observation thereafter directed to the maintenance of patency of the cervical canal.

"Reversed menstrual drainage" is a term which might advantageously be coined to express the pathogenesis of a group of affections which develop insidiously and persistently, with disturbance of pelvic function in the early stages, and eventual development of extensive pelvic pathology. Although many are contrary minded, accumulated evidence furnishes ever-increasing support to Sampson's theory that retrograde menstruation and implantation of spilled fragments of Muellerian tissue account for the majority of cases of pelvic endometriosis. The cause of reversed drainage is found most frequently in persistent retrodisplacement of the uterus, but laxity of uterine supports with relaxation sufficient to permit temporary retrodisplacement accounts for many cases. Less well recognized, and extremely important, is a large group of cases in which obstructed drainage from the uterus produces a backflow and a pelvic spill. If the opened abdomen reveals endometriosis in the absence of retrodisplacement or relaxed uterine supports, one may unhesitatingly diagnose and can demonstrate an obstructing lesion of the uterus. There is only one exception—a history of intrauterine instrumentation which might have produced a spill. The obstruction need not be a stricture, a projecting submucous fibroid or an occluding polyp may be equally effective.

I shall not stop to dwell on the importance of menstrual backpressure in the causation of adenomyosis and fibroids of the uterus, but even my own limited personal experience suffices to impress me with the importance of this factor in the etiology of uterine tumors. Still further, I am in sympathy with the sentiment expressed by Graves, that the greatest avoidable cancer menace is inadequate genital drainage. And I would add that we must not overlook microscopic obstruction, for it rivals gross obstruction in importance.

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ABDOMINAL AND PELVIC PAIN—FROM A GYNECOLOGICAL VIEWPOINT

ARTHUR H. CURTIS, M.D., F.A.C.S., Chicago, Illinois

IT is not my intention to present a comprehensive gynecological survey of abdominal and pelvic pain, but rather to concern myself with selected topics which appear to merit our attention. If I deviate from the subject of this paper and I shall do so, it will be with malice aforethought, and with the object of adding to the interest of my offering in this I beg your indulgence.

Pain in the right upper quadrant. In 1929 I called attention to the incidence and clinical significance of anterior liver surface adhesions. I refer to adhesions in the subdiaphragmatic anterior liver surface region in the absence of generalized adhesions or other local pathology which might account for their presence.

All told, since a detailed record was begun in 1928, I have operated on 56 patients with adhesions ascribable to gonococcal infection. Eight other atypical cases were probably ascribable to the gonococcus. Strangely enough only 10 cases throughout these 9 years were either apparently or definitely non-gonorrheal. These do not include non-operated upon patients, of whom there have been a score or more some with evidence of gonococcal infection in the active stage many more with a history of genital disease and associated characteristic symptoms in the right upper quadrant 'liver region pain'.

The route traveled by the gonococcus in reaching the subdiaphragmatic space has not been determined. It is assumed that it is by a process of direct extension—presumably along the para-vertebral gutter.

There may be no history of pain; the discovery of the adhesions being merely a casual finding incidental to an abdominal operation for tubal disease. More frequently, postoperative inquiry yields a story of a former right-sided pleurisy or gall bladder trouble or perhaps right intercostal neuralgia.

Although most commonly recognized incidental to abdominal exploration, symptoms of peritoneal involvement in the region of the liver are not

uncommon during the acute stage of gonorrheal disease of the pelvic viscera. The symptoms are seldom noted by the attending physician because they are obscured by the more severe pelvic symptoms or they escape recognition because the upper abdominal distress is ascribed to gaseous distention, a common complaint in these patients. Once looked for, the diagnosis during the acute stage is simple; there is localized distress in the right upper quadrant in the region of the liver often accompanied by a friction rub.

From the viewpoint of operative intervention nothing is necessary, nor is relief of the pain a serious matter, for it seldom exceeds that of a moderate pleurisy and as a rule is limited to a period of a few days. But from a diagnostic viewpoint, this is an important affection. In the acute stage it may be confused with biliary colic, or acute pleurisy. It is especially in relation to pelvic disease, however, that the recognition of anterior liver surface adhesions is important. On a few occasions I have been able to speak with greater certainty about the diagnosis of a pelvic mass because questioning has yielded a history of liver adhesion pain. At operation before exposure of the pelvic viscera initial palpation of these adhesions in the upper abdomen is pathognomonic evidence of tubal disease particularly in differentiation of the etiology of hydrosalpinx, of salpingitis isthmica nodosa and of pelvic adhesions of undetermined etiology (the accompanying presence of anterior liver surface adhesions bespeaks a gonococcal infection).

Dysmenorrhea. For the sake of clarity I shall now describe the pelvic plexus more commonly known as the uterovaginal plexus, the cervical ganglion, or the ganglion of Frankenhauser, which furnishes the chief nerve supply to the pelvic organs. It is because there is much erroneous description and much confusion concerning this plexus that a brief description appears appropriate. It is a bilateral thin sheet of nerve fibers and fascia spread out over an area of by 3 centimeters upon the lateral aspect of the ampulla of the rectum situated in the broad ligament at the level of the cervix; the plexus is somewhat lateral to the lateral fornix of the vagina upon the posterior surface of Mackenrodt's ligament. It is

From the Department of Obstetrics and Gynecology, Northwestern University Medical School.

Presented in the Symposium on Obstetrics and Gynecology before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.

manipulation of the nerves of Frankenhaeser's plexus which causes the patient to groan, even under deep anesthesia, at the time of clamping the cervical supports during a vaginal hysterectomy.

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completely escaped my detection until recent years, and in many instances the etiology and exact diagnosis of the nerve pain still remain elusive. Sometimes a vague vaginal pain is unmistakably localized in an apparently innocent rectocele, but it is to deep-seated pain that we can now most profitably direct our attention.

Pain ascribable to lesions of the pelvic viscera is apparently always transmitted through the pelvic plexus (Frankenhauser's ganglion). A majority of the afferent nerve fibers travel upward through the superior hypogastric plexus the so-called presacral nerve. Resection of the presacral nerve may, apparently, be depended upon to relieve dysmenorrhea, but pain ascribable to deep-seated cellulitis and lesions in other more remote regions may demand other procedures.

James Young, of London, uses the term "broad ligament neuritis" to express the symptom complex produced by chronic cervicitis and believes that not only localized broad ligament pain but also distress more diffusely spread over the abdomen and back and extended down the thighs may likewise be explained on the basis of infection of the cervix. I am in accord with the thought that infection of the cervix particularly that associated with blocked drainage is an important factor in deep-seated pelvic pain, but we find that more widespread distress such as chronic aches in the lateral abdomen and groin and thighs is more often identified with arthritis and nerve root lesions.

Some years ago I became aware that an exhaustive and detailed history combined with a painstaking examination permits one to determine almost invariably whether a headache is of gynecological origin or requires the services of an orthopedist. In the course of those clinical studies many previously unrecognized tender spots were encountered. It was learned that poorly described and ill defined regions of distress can be accurately localized upon deep pelvic palpation with the patient placed in various positions with digital exploration directed along the entire pelvic wall, the sacrum and the coccyx. In this connection I wish chiefly to emphasize that there is definitely localizable pelvic pain outside the region of the pelvic viscera characterized by excruciating tenderness along the lumbosacral nerve roots, and that this pain along the wall of the pelvis although sometimes identified with cervicitis is characteristic of lesions of the bones, ligaments and fascia of the pelvis usually amenable to relief by the orthopedist and sometimes, when he fails, by the neurologic surgeon. X-ray study of such cases is commonly confirmatory of the pelvic findings, but the

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In summarizing these remarks on pelvic tooth ache it may suffice to state that the gynecologist can often relieve pelvic suffering by preacral nerve resection or by treatment or removal of diseased genitalia but there are many other deep-seated neurological affections of the pelvis which we may detect because of our experience in pelvic examination which belong in the domain of the neurologic surgeon or in the hands of the orthopedist.

Postoperative distress. Postoperative adhesions are a cause of much suffering and I am an advocate of operative intervention for their relief. Local distress persistent after correction of intestinal disorders and stagnant elimination is almost pathognomonic of adhesions and does not commonly require x-ray study for confirmation of the diagnosis. The x-ray is helpful in selected cases but it is too gross to be depended upon in a great percentage of cases, just as it may be ineffectual in a search for the cause of a headache.

"Once adhesions, always adhesions" is an axiom which should not apply in present-day surgery of the lower abdomen. Adhesions above the level of the navel tend to recur despite careful technique. But lower abdominal and pelvic adhesions are amenable to correction if we are willing to operate deliberately painstakingly and gently with employment of rubber protective and avoidance of roughing the peritoneal surfaces with gauze.

If the pelvic structures are left rigid at the close of a pelvic operation by the abdominal route there is considerable hazard of subsequent discomfort on physical exertion and during sexual contact. There is a still greater incidence of an undesirable rigidity as an aftermath of operations by the vaginal route. Adequate support is imperative as is universally recognized, but we have failed to copy nature in leaving the tissues pliable and mobile. Like the modern tailor who is forever insistent on tight, good-looking clothes, the gynecologist may unwittingly be the cause of suffering. To produce a vaginal vault free from tenderness and a vaginal canal which is pliable and comfortable—adequately repaired yet not too tight—is difficult. Particularly in patients subjected to vaginal hysterectomy with at the same time a correction of a cystocele and a rectocele it is difficult to leave an adequate comfortable canal. In the repair of extensive relaxations of the ante-

rior wall together with rectocele, anatomical restoration may tempt one to connect the anterior and posterior incisions in the vaginal vault. It is preferable not to do this, but rather to leave a soft bed in the region of the posterior vaginal fornix, where nature originally provided a soft cushion. In closure of the cystocele wound the mucosal sutures may well include the underlying fascia, thus maintaining a normal deep concavity, in contradistinction to a tensely sutured less concave anterior wall.

In rectocele repair approximation of the levator ani may be indicated. But it is well to remember that nature placed very little muscular tissue between the vagina and the rectum and a repair with nothing more than firm musculo-fascial support overlying the rectum suffices in cases in which approximation of the levator ani produces a too tense perineum or undue constriction of the vaginal canal.

Dyspareunia Persistently painful intercourse during the honeymoon, and sometimes protracted thereafter until childbearing, when not ascribable to an inflammatory process is most often caused by traumatism of the anterior vaginal wall. Hasty coital entrance into a tight canal may be accompanied by a "hang" at the urethral meatus, which becomes everted and sags and often excruciatingly tender. The lesion is self-evident when searched for, although it escapes detection on casual examination. Suggestions to the husband and wife relative to the details of contact without injury commonly suffice, except in unusual cases in which perineotomy is required.

We have long been vaguely aware of the incidence of dyspareunia from dryness and from shrinkage of the tissues after the menopause, but we have been dilatory in affording relief. Only recently has there been adequate recognition of the severity of so called senile vaginitis and appreciation of the etiological importance of estrin deficiency in the causation of this disturbance. Endocrine therapy may restore the normal glycogen content in the vaginal mucosa and thus result in the return of the normal flora, normal vaginal acidity, and natural moisture of the tissues. Vaginal suppositories of cocoa-butter or other innocuous substances are helpful adjuncts.

Perineal pain Distress during labor, intractable pruritus, and neuralgic pain in the perineum may require unusual measures, such as nerve blocking or resection of the perineal nerves. Nerve blocking has some advocates among our obstetricians. Open operations for nerve resection have heretofore been neglected by most gynecologists or have been referred to the neuro-

logic surgeon. With the thought that these topics may be of interest, I shall digress to point out the anatomical landmarks of importance in nerve blocking of the perineum and in nerve resection for the relief of pruritus and kindred ailments.

Alcock's canal, formed by the fascia covering the obturator internus muscle, contains the internal pudic artery and veins and the pudic nerve. With the patient lying on her back with the thighs flexed, in the usual position for a perineal operation, the extended forefinger of the seated surgeon pointing into the depths in the region of the tuber ischium is directed toward Alcock's canal, which lies on the medial surface of the bone within the margin of the tuberosity and at a slightly lower level. This is a favorable site for anesthetic blocking of the pudic nerve.

A more detailed knowledge of the branches of the pudic nerve is necessary if resection is required for relief of intolerable itching (*pruritus vulvae*). One or two inferior hemorrhoidal nerves are given off soon after the nerve leaves Alcock's canal. The main trunk of the pudic nerve courses forward, becomes superficial, and divides into the perineal nerve and the dorsal nerve to the clitoris. The perineal nerve has 2 branches, 1 superficial, 1 deep. The first branch of the deep perineal nerve goes to the anterior half of the external sphincter ani and should be spared. All other branches may be destroyed. Surgically, the perineal nerve may be isolated, bilaterally, by a perineal incision parallel with and 1 inch mesial to the rami of the ischium and pubis, extending posteriorly to the anterior level of the anus. Dissection will reveal the posterior border of the superficial transverse perineal muscle, around which the nerve and vessels turn upward to reach the perineum. It will be remembered that the superficial perineal muscle is a firm band extending from the tuber ischium to the central point of the perineum. Tracing the fibers toward the nerve trunk enables one to find anastomoses with the other nerves which contribute to the sensory supply of the perineum. These are the perineal cutaneous branches of the ilioinguinal, genitofemoral, posterior femoral cutaneous, and the sacral and the anococcygeal nerves.

Cancer pain Many years ago Dr Watkins and I came to a realization that morphine is unsatisfactory as an analgesic in cases of genital cancer. The explanation is simple. Cancer pain is continuous. Morphine relieves suffering for not more than a few hours at the most. As the patient becomes habituated to the drug, continuously increasing dosage is required. Even with pain of moderate severity, considerable distress is evi-

completely escaped my detection until recent years, and in many instances the etiology and exact diagnosis of the nerve pain still remain elusive. Sometimes a vague 'vaginal pain' is unmistakably localized in an apparently innocent rectocele but it is to deep-seated pain that we can now most profitably direct our attention.

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CESAREAN SECTION

JOHN R. FRASER, M.D., C.M., F.A.C.S., and DOUGLAS SPARLING, M.D., Montreal, Quebec

ONE of the important questions still engaging attention in obstetrics is the determination of the part cesarean section should play in the treatment of obstetrical complications

In the Canadian government report on Maternal Mortality (1935) three statements appear which will bear remembrance

1. In spontaneous deliveries the estimated specific mortality rate was 2.3 per 1000 live births, while in non-spontaneous deliveries it was 8.2

2. In 18 per cent of the delivered cases (221) a cesarean was done

3. Of women dying of eclampsia who were delivered, about a third followed cesarean section

The American Committee on maternal welfare in a special report on toxemias of pregnancy estimates that eclampsia and allied forms of toxemia are responsible for 30 per cent, approximately, of 15,000 maternal deaths in the United States each year. It is well, the report states, "to understand at the beginning that the toxemias are non-surgical conditions requiring medical treatment in the majority of cases. Careful examination reveals that the death rate in some localities is 20 per cent following cesarean section or other operative measures for eclampsia."

Perhaps at no time in the history of obstetrics has there been a more influential body of opinion directed toward the understanding and possible regulation of the rising incidence of cesarean section with its attendant risks, than at the present time. One year ago at the annual meeting of this College, Frank Lynch, director of the department of obstetrics and gynecology, University of California, made a most impressive contribution to the further understanding of this problem in an address dedicated to "More Conservatism in Cesarean Section." Many important facts emerged from this study. He established the fact that more than half of the cesarean deaths had occurred in women who previously had given birth to children through the normal birth passages. Some idea of the widespread performance of the operation may be deduced from the statement that cesarean section preceded 11 per cent of all puerperal deaths in or after the seventh month of

pregnancy in the 15 states reporting for 1927-1928. In point of fact 0.76 per cent of all women delivered in the United States in 1934 were by cesarean section. In hospitals the incidence rose to 2.8 per cent of all hospital births.

Table II prepared by Greenhill shows the steady rise in the incidence of the operation in a large hospital. Lynch draws attention, however, to the fact that even with this operative increase there has not been a compensating decrease in mortality generally.

The general and increasing popularity of the operation has not, as might be expected, led to a more precise clarification of the indications for its performance; on the contrary, as the result of sporadic successes the list of relative indications has been widely extended with resultant confusion. The sound principles which have always governed the indications for operation are being lost sight of, in a desire to deliver the women through the abdomen when and if any serious obstetrical abnormality arises.

It is perfectly true that in carefully selected cases under proper conditions and before labor has commenced the operation may be carried out successfully with a mortality of 1 per cent or even less. Witness the series reported by Greenhill, Arnott of Lynch's clinic and Paul Bar of Paris. On the other hand when conditions are not ideal

TABLE I—VARIOUS INCIDENCES OF CESAREAN SECTION (C. Jeff Miller)¹

Hospital	Ratio to deliveries
Bellevue	1 to 97
Boston Lying-In	1 to 12
Burnside	1 to 861
Cook County	1 to 88
Detroit	1 to 277
Jefferson	1 to 36
Long Island College	1 to 125
Melbourne Woman's	1 to 103
New England Hospital for Women and Children	1 to 102
New Orleans	1 to 52
New York Lying-In	1 to 585
Potter	1 to 14
Rotunda	1 to 195
Sloan	1 to 36
San Francisco	1 to 40
Swedish	1 to 201
University College	1 to 176
Johns Hopkins	1 to 77

¹ Surg., Gynec. & Obst., June 1929, p. 745

Presented in the Symposium on Obstetrics and Gynecology, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937

dent after 2 or 3 hours and from then on one is in a quandary whether to repeat the medication or to prolong the suffering. The net result is a patient who is made to suffer much of the time because morphine has been rightfully withheld as long as possible, added to the ravages of the disease and to part time suffering ascribable to incomplete analgesia is superimposed addiction to morphine in itself a terrible affliction. With aspirin and codeine, and perhaps with kindred remedies which are not habit forming the average patient can be maintained in peace and in relative comfort until the end. One should not be too sparing with codeine, for Walter Haines repeatedly stated that $\frac{3}{4}$ grain of morphine is the equivalent of 2 grains of codeine, and the latter is habit forming in the rarest of instances. Our customary dosage in cancer cases is 1 grain, seldom more than $1\frac{1}{2}$ grains. Sometimes codeine produces nausea, but not often. Its chief assets in cancer are that it is not habit forming and habituation does not necessitate increasing dosage. Discussion of other drugs would lead us too far afield and would also carry me beyond my depth.

I cannot extricate myself from the subject of cancer without mention of other means of affording relief from intractable pain. It has been my fortunate experience that fully 90 per cent of patients require nothing more than aspirin, codeine, and attentive care. In the terminal weeks when the patient goes from bad to worse, I have no objection to morphine, provided life expectancy is short. My experience with intrathecal administration of alcohol is too limited to warrant an expression of personal opinion. By the grapevine route I gather that it is not uniformly

satisfactory but gives considerable, although in adequate, relief in most cases. With the patient in a lateral position for lumbar puncture, the most painful side of the body uppermost, the hips elevated on a pillow, and the head lowered a few cubic centimeters of spinal fluid are withdrawn and discarded before slow instillation of not more than 0.8 cubic centimeter of absolute alcohol. The patient is maintained in this position for 20 minutes or more, and the head kept lowered for an additional hour at least. Relief may come only after several days. If the pain is bilateral, spinal instillation with the other hip uppermost may be resorted to later. Repeated treatments should be given with circumspection, and rarely in an amount of more than 1.0 cubic centimeter.

Bladder disturbances and other complications are seldom serious but degenerative changes are a sufficient hazard to contra-indicate this therapy in other than those whose prognosis is hopeless.

Chordotomy is out of the gynecological operative picture, but proper care of our patients requires an acquaintance with its indications and limitations. Extracts from a letter of Max Yee, September 30, 1937, are of interest. He states:

We are still doing chordotomies for relief of intractable pain, not only of the pelvis but as high as the cervical region. I still prefer to perform the operation under local anesthesia, so that I can test the patient to determine whether I have a sufficiently high level of analgesia. A high chordotomy at the level of the first or second thoracic vertebra is less difficult than at a lower level and is easier on the patient.

TABLE III.—STATISTICS COMPILED BY BLACKER

	Number of cases	Maternal mortality	
		No	Per cent
Bar	97	0	
Schauta	128	0	
Kerr and Holland	1591	26	1.6
Armand Routh	469	14	2.9

rate of barely 2.2 per cent. In our disproportion group 187 of a total of 216 cases, i.e. 87 per cent were operated upon before labor ensued, with a mortality rate of 1.3 per cent. This mortality was a small proportion of that for the entire series, although it represented the end-result in the largest single group of the series, cases in which infection might reasonably have been expected inasmuch as the history of many of them revealed a stormy convalescence following previous delivery from below.

In marked disproportion, the case is well made for the woman who can have an elective operation under ideal conditions. It should carry with it no complications. Very different is the woman with a border line pelvis, in whom, in spite of careful examination, there is definite doubt as to the outcome. Here a test of labor may be deemed advisable. If the time honored regulation "test of labor" be employed, it implies 2 hours of second stage pains with a dilated cervix and ruptured membranes. Such "trial of labor," even under the best conditions, is a severe test of cesarean section irrespective of the type of operation employed—under any but ideal conditions it might be highly dangerous.

The observation of the influence of labor for shorter periods may be informative and permit of some differentiation as to the direction which the future course of labor must take—undoubtedly the low cervical operation in some form is best suited to such conditions. It is, nevertheless, true in our own experience that the more closely the trial of labor is made to correspond to what is generally accepted as such, the greater will be the risk to both mother and child, even under the best conditions. While Lawson Tait, in 1895, advocated section in the treatment of placenta previa, it is only of relatively recent date that its value is becoming more widely appreciated. The performance of the operation for the central variety has been practiced much longer than for the less marked forms. The combination of blood transfusion, local anesthesia and cesarean section is in many clinics becoming to be the treatment of preference for not only the central, but many of the lateral, varieties as well. In our series 25 patients were operated upon in this way with no maternal mortality.

TABLE IV.—INDICATIONS

	No	Total	
		No	Per cent
Disproportion	216	38	3
Previous section	123	21	9
Placenta previa	25	4	4
Elderly primipara	19		
Chronic nephritis	26		
Pre-eclamptic toxemia	23	9	6
Eclampsia	5		
Cardiac disease	16		
Elective	34	6	0
Soft tissue dystocia	15		
Ovarian cyst	6		
Pulmonary tuberculosis	5		
Fibroids	11		
Miscellaneous	38		
Total	562		

Accidental hemorrhage. Of late years the employment of cesarean section in retroplacental hemorrhage has become a more frequent procedure. The situation is very different from placenta previa. Usually one is dealing with the late stage of toxemia. The child often succumbs before any therapy can be initiated and the indication for operation must be purely in the interest of the mother. It is true that in a few instances failure of the uterus to contract, with therefore constant bleeding, might compel one to interfere by cesarean section and possibly a Porro operation, but in most circumstances the more accepted conservative measures will suffice to control the situation. This group is not ideal for any prolonged or severe surgical intervention.

Toxemia of pregnancy and chronic nephritis formed 9.6 per cent of the series. In eclampsia the operation was performed on 5 occasions with 3 deaths. In the pre-eclamptics and chronic nephritics there were no deaths. It is clearly evident that the eclamptics were not well chosen, the disease being very severe in each instance, but the result to some extent was in keeping with experience generally, and confirmed us in the belief that the performance of the operation was an unwise decision. It would seem that cesarean section has little or no place in the therapy of eclampsia when the end-results are contrasted with those now being obtained from palliative treatment, where the mortality is about 5 to 8 per cent.

Adair has demonstrated the value of section in the pre-eclamptic, especially when in addition to toxic manifestations failing to ameliorate under treatment, there may be an associated mechanical lesion. Then, under local anesthesia, the risk seems justifiable.

Any widespread adoption of the operation in the toxic woman, however, must inevitably fail if the usual criteria for surgical healing mean anything.

TABLE II—SHOWING RISE IN INCIDENCE OF CESAREAN SECTIONS

Year	Total deliveries	Class c cesareans	Cervical cesareans	Porro operations	Total cesareans	Incidence of all cesareans per cent	Del. eries per cesarean
1915-16	1430	0	6	0	25	0.6	161.0
1916-17	1184	12	6	3	20	0.9	166.7
1917-18	1891	20	10	2	32	1.1	90.5
1918-19	3393	20	21	1	42	1.2	8.8
1919-20	3253	25	14	1	40	1.2	16.0
1920-21	3342	14	30	3	46	1.4	73.1
1921-22	3683	10	54	1	65	1.8	56.7
1922-23	3885	9	68	2	78	2.0	49.8
1923-24	6063	4	93	3	100	2.3	40.4
1924-25	4312	6	109	4	119	2.8	36.1
1925-26	4359	3	109	7	119	2.7	36.6
1926-27	4307	3	112	8	123	2.8	33.1
1927-28	4658	5	120	3	128	2.7	33.4
1928-29	4603	4	132	3	139	3.0	31.7
Total	51323	127	874	33	1034		

it can be associated with disastrous results. Munroe Kerr of Glasgow recorded the results in a series of 220 women operated upon late in labor in which there were 22 deaths a mortality of 10 per cent. When in addition there had been preliminary efforts to deliver from below the mortality quickly rose to 27 per cent.

Table III compiled by Blacker illustrates the results in carefully selected cases.

Aside from the immediate mortality risk there are many points of future importance to the woman which demand careful consideration. The classical and indeed the low cervical operations are frequently associated afterward with varying degrees of infection which influence healing and may leave a weakened scar to offend in future pregnancy or labor. Infection lying dormant may in future cesareans prove to be a grave danger. Perhaps a point of even wider significance is the fact that having launched the woman on a surgical career she will in all likelihood have to continue in this way throughout her entire obstetrical life—surely a matter of some importance to a very young woman. In our series in Montreal there were 123 instances in which section had been performed before (21 per cent of all cases). In this group alone there were 4 maternal deaths, or 3.2 per cent, and 5 fetal deaths 4 per cent. Sparling, in a recent review of 24,856 deliveries in the Royal Victoria Hospital Montreal both in the hospital and dispensary services in a period from 1927 to 1936 found that 562 cesareans had been performed an incidence of 2.2 per cent or 1 in 44.3

deliveries with maternal death rate of 3 per cent, a fetal death rate of 8.3 per cent and a morbidity rate of 61.92. In our clinic a case is considered to be morbid with a temperature of 100.6 degrees on any one occasion during the neonatal period save the first 24 hours.

The accepted indications for cesarean section the world over have always been marked pelvic contraction, cephalopelvic disproportion, obstructions of the birth canal by neoplasms or atresia through the narrowing of the cervix or vagina. Lawson Tait suggested placenta previa and more lately certain toxic states have been included. The apparent safety of the low cervical operation has encouraged the inclusion of many other relative and questionable indications.

In our own series cesarean section was performed in the bulk of the cases for the following reasons:

1. Pelvic contraction or cephalopelvic disproportion
2. Neoplasms obstructing the birth canal
3. Hemorrhage (placenta previa)
4. Toxemia
5. Repeat sections

Although well defined architectural changes in the pelvis govern the performance of the operation in so many instances it is well to recall the experience of Schauta in a large series of 50,000 deliveries in which in 5,283 women varying degrees of disproportion were encountered. In 4,116, or 77.8 per cent spontaneous deliveries occurred with only 4 maternal deaths and a fetal death

SYPHILIS IN THE PREGNANT WOMAN

JAMES R. McCORD, M.D., F.A.C.S., Atlanta, Georgia

IT IS probable that the following statement is too conservative. a woman with a strongly positive blood Wassermann reaction who becomes pregnant and who does not receive antisyphilitic treatment during pregnancy has only about a 35 per cent chance of giving birth to a living, healthy baby. The same woman with adequate treatment during pregnancy has a 95 per cent chance of giving birth to a living, healthy baby.

Rather than try to cover the subject assigned me with a statistical review and a maze of figures, I am going to give you my own opinions of the subject, gathered from an experience of some 3,000 cases.

It seems wise, in the light of present knowledge, to teach that congenital syphilis is always the result of the disease in the mother. In other words, the direct transmission of syphilis from the father to the fetus probably is not possible. The activity of the syphilis in the mother seems to be the determining factor as to whether the fetus will or will not be syphilitic. In so far as I know, there is no sure method of knowing what the activity of the disease is in pregnant women.

The diagnosis of syphilis in pregnant women must, in the large majority of instances, be made from a properly done blood Wassermann test that is positive. It should be emphasized that these tests should be done in well organized laboratories and not in doctors' office laboratories by mildly competent technicians. A positive test that has been properly done means syphilis. Pregnancy does not cause false positive reactions. It does cause many false negative reactions. We have autopsy material in our laboratory in which the organisms of syphilis were demonstrated in 221 abortions and babies at all periods of gestation. One blood Wassermann reaction during pregnancy or at the time of labor was negative in 29 per cent of the mothers. In a recent study of 175 stillbirths (colored) at all periods of gestation, the pathognomonic bone changes of congenital syphilis were found in 37 babies, an incidence of 20 per cent. The maternal Wassermann reaction was negative in 16, an incidence of 43 per cent. This, to me, is a disturbing problem that must

be constantly kept in mind and upon which more work must be done. Repeat Wassermann tests would probably have been positive in some of these women but this cannot always be done. We must be on the alert for such cases and not put implicit faith in one negative Wassermann reaction. Careful histories and physical examinations will, many times, indicate treatment during pregnancy though the Wassermann reaction be negative. In our clinic it is the rule to repeat a positive blood Wassermann test before beginning antisyphilitic treatment. At the present time it is not possible to repeat all the negative tests. Increasing experience has taught us that a weakly positive Wassermann reaction during pregnancy demands careful consideration and means more than in the non-pregnant. It is a safe rule to treat pregnant women with positive blood Wassermann reactions during each pregnancy even though prior treatment has reversed the reaction.

Syphilis is transmitted to the fetus from the mother by the placental circulation. Theoretically, there should be placental syphilis with every syphilitic baby. This is probably true but often not demonstrable.

What do we mean by antisyphilitic treatment during pregnancy? What are its limitations? What are its dangers? When should it begin and how should it be controlled? What results can be obtained?

I think that it is the generally accepted opinion that the basis of such treatment is to prevent syphilis in the baby. Do not attempt to cure the disease in the mother. It is our opinion that some of the serious results that have been reported were caused by neglect of this fundamental principle. Treatment should begin as early in pregnancy as the diagnosis is made and should be continued until labor begins. The treatment should be continuous, mild, and gentle. Moore states that treatment begun early in pregnancy prevents the disease in the fetus and that treatment begun later in pregnancy cures the disease in the fetus. Treatment begun before the fifth month of pregnancy and continued weekly until labor begins practically guarantees the woman a syphilis free baby.

If treatment is started early in pregnancy, an alternating course of arsenic and a heavy metal can be used. Arsenic should be the first and the

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TABLE V—RESULTS OF CLASSICAL AND LOW CERVICAL CESAREAN SECTION

Results	Classical		Low Cervical	
	No	Per cent	No	Per cent
Poor or stormy convalescence	67	26.5	14	13.4
Maternal deaths	9	3.2	4	3.8
Fetal deaths	25	6.1	3	2.8
Maternal morbidity	240	60.0	63	60.0

Repeat sections Previous section accounted for 123 cases, or 21.9 per cent of the entire series. In 1927, 12 per cent of all operations were in women who had previously had a cesarean. By 1936 this figure had risen to 34 per cent. This fact speaks the desirability of using the greatest care in the selection of cases for the primary operation for, in the light of mortality alone, repeat section must be considered in our experience as even more risky than the primary operation.

Even though the low cervical operation be more widely employed than the classical, especially in the cases of relative indication such as placenta previa and granted theoretically that vaginal delivery be safer thereby in later pregnancies, it must be conceded that for one reason or another, experience will show that future pregnancies are likely to be terminated again by section.

THE CLASSICAL VS THE LOW CERVICAL OPERATION

In the Montreal series there were 406 classical and 104 low cervical operations. Table V depicts the results in each group.

The classical cesarean section is satisfactory under ideal conditions such as should obtain in the elective operation. It is technically more easily performed but reveals often the decided disadvantage of imperfect healing and therefore leaves the uterus with a weak scar. It is at a disadvantage in the presence of infection and may be associated with the formation of adhesions leading to bowel obstruction.

The low operation on the contrary while more difficult of execution by reason of its position in the lower uterine segment is obviously a safer operation in that the wound is more apt to heal firmly situated as it is in a quieter sector of the uterus. It is better situated for nature to combat infection and increasing experience is demonstrating that it will more safely allow of future delivery through the vagina.

The surgeon doing the occasional cesarean however, will not find this operation easy of accomplishment.

Perhaps the suggestion of Piper and Bachman of the selection of the lower part of the true uterus for the classical operation may under certain circumstances be useful.

CONCLUSIONS

1 The incidence of cesarean section is too high.

2 While it is admitted that cesarean section for the classical indications of pelvic disproportion or obstruction of the birth canal under ideal conditions, can be made a relatively safe operation it is in actual practice associated with a very definite mortality.

3 The broadening of the indications for the operation has definitely increased the risk for both mother and child.

4 The low cervical operation has tended to decrease the risks in the presence of labor or potential infection, but has not removed them entirely.

5 Many women being subjected to cesarean section today would be more suitably dealt with by more conservative obstetrical measures.

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CONFERENCE ON TRAUMATIC SURGERY

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FREDERIC A. BESLEY, M.D., F.A.C.S., Waukegan, Illinois

ON this occasion of the tenth conference on Industrial Medicine and Traumatic Surgery, it would seem fitting to review the progress of the teaching of these very important subjects in our medical schools as such instruction is related to the ever increasing demand for trained men in this branch of medicine

Unfortunately there are only a few schools where the deans and faculties have given any thought to changes in their curricula to meet the rapidly changing conditions demanding trained medical men capable of meeting the requirements of such service as changing conditions are demanding

How many of you have been confronted with the difficulty of securing a younger man for a position requiring the qualifications necessary to deal with industrial diseases and injuries? How frequently are you asked by these younger men where they may go to secure adequate training in industrial medicine and traumatic surgery? There are few such opportunities for securing the desired training, and in visualizing the future it is axiomatic that arrangements must be made to provide this training

A brief analysis of existing conditions as they now prevail in the surgical departments of a majority of medical schools may be enlightening. Within recent years there has been a tendency toward narrower specialization, and the term "general surgery" is rapidly losing its significance and concrete meaning. Formerly the teaching of fractures was done by the general surgeon, but more recently the orthopedist is claiming the bone and joint injuries, and in some institutions the diagnosis and treatment of these lesions are being taught by these specialists. Perhaps this is as it should be. One sometimes wonders how proficient the orthopedist becomes in the recognition and treatment of brain injuries, a punctured lung or an injury to the solid or hollow viscera below the

diaphragm. Can the curricula of the medical schools be arranged so that these subjects may be presented intelligently to the student by the various special departments so that he may acquire a basic knowledge of these subjects, or should there be established a separate department for the teaching of industrial medicine and traumatic surgery—a knowledge of which is becoming more and more important and essential for the medical student because of the increasing number of workers in industry and consequently the larger number of patients affected by the accompanying hazards of centralized industries.

Obviously deans of medical schools and many members of the faculties are not cognizant of, or familiar with, the practical problems that occur in this field of medicine, and it should not be the purpose of such a group as constitutes this audience to indulge in destructive criticism of their teaching methods. Quite the contrary. It is our plain duty to help in every way to clarify the situation and to co-operate with teaching groups in bringing about a more comprehensive course of training in this branch of medicine.

Again may I express my confidence in that group of men, who are known as industrial surgeons, to continue to act as pioneers in blazing the trail for the better teaching of these subjects. They are accustomed to opposition but their characters have been such that they have surmounted these difficulties and established themselves in their chosen field as men of foresight and ability. May I urge them to aid in every way in establishing opportunities for postgraduate training in this department.

This can be done only by the concentration of a large number of cases in one teaching center, and we are not unmindful of the importance of the co-operative influence of large industries and insurance companies in bringing about such a situation.

The American College of Surgeons pledges its efforts in the direction of creating greater opportunities and facilities for the teaching of industrial medicine and traumatic surgery in medical schools and hospitals.

Chairman's address presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937

last drug to be used. It is our opinion that arsenic and a heavy metal should be used concurrently if treatment is started late in pregnancy.

Shall arsphenamine or neoarsphenamine be used? It is our opinion that it is better to use the one with which you are the more familiar and can best administer. Either one used in the right way, gives excellent results.

Which metal is to be used, bismuth or mercury?

We prefer mercury for the following reasons although most syphilographers believe that bismuth is of more value in curing syphilis, we should remember that we are not attempting to cure the disease in the mother, we are trying to prevent the disease in the baby. It has been our experience that women will be much more inclined to follow treatment faithfully if there is no discomfort, and mercury surely causes less discomfort than bismuth. We think that mercury is less toxic than bismuth. The toxicity of any drug is to be considered seriously in treating pregnant women. We use two small mercurial inunctions weekly. However, bismuth can be used with the highest authority. After all, there is no quibble as to how to treat. The commandment is treat and treat early continuously and gently.

Mild but unpleasant reactions from arsenical treatment during pregnancy can usually be avoided. Particularly in large clinics time is not taken to explain to the patient what is being done. Treat with the stomach empty and after a mild laxative. Take the blood pressure and examine the urine for albumin before each treatment. Question the patient carefully about any sort of reaction from the last dose. If in doubt play safe and omit treatment until you are sure. Emphasis should be given to the fact that all arsenicals given intravenously must be given slowly. Rapid administration will cause reactions in pregnant women.

Repeat blood Wassermann tests during treatment are not necessary and probably not desirable. Cessation of the treatment because of a negative Wassermann reaction is inexcusable.

Perhaps the general opinion is that cord Was-

sermann tests are of no value. However this is not our opinion. A negative cord Wassermann reaction is of little value in deciding that a baby does not have congenital syphilis. Our experience has been that it is only the occasional baby who has a positive cord Wassermann reaction that does not develop other manifestations of congenital syphilis. We did cord Wassermann tests on 1,372 living babies born of Wassermann positive women. The incidence of positive cord Wassermann reactions in the babies of those women who did not receive treatment was 21.2 per cent. There was a positive incidence of only 2 per cent in the babies of the women who received good treatment. The number of positive cord Wassermann reactions in premature babies was double that of the term babies.

We have reviewed our records of 66 dead babies at all periods of gestation in whom the organisms of syphilis were found and whose mothers had negative blood Wassermann reactions. Cord blood is often difficult to obtain from dead babies and was obtained from only 21 of these 66 babies. Of these, 9 were negative and 12 positive, 57 per cent. Every baby that had a positive cord reaction had the bone changes that we think pathognomonic of congenital syphilis. Seven babies had a negative cord reaction and positive bone changes. Perhaps you do not think that a positive cord Wassermann reaction is of any value. It should at least put you on guard and usually within 4 months or less the blood Wassermann will be positive and you can institute treatment. All babies born alive of Wassermann positive women should be intensively observed and examined with frequent blood Wassermann tests for at least 1 year.

The fact that roentgenograms of the long bones are of great value in diagnosing congenital syphilis is strengthened by the following figures. Roentgenograms of the long bones were made on 56 of the 66 babies in whom the organisms of syphilis were found and 94 per cent showed the characteristic lesions of congenital syphilis.

There seems to be no other disease where preventability is more simple than in congenital syphilis.

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not only for the industry as a whole, but for specific types of operations. Through this means the relative degree of hazard in various parts of a plant can be appreciated, and, if there is an effective segregation of occupational groups, a sharp distinction can be made between hazardous and non-hazardous occupations. Moreover, the effect of changes in operating procedure can be recognized. However, the symptomatic and physical signs of dangerous lead absorption, by their very nature, are evident in large part after the fact, rather than before it. Therefore if the occupational lead exposure is of such magnitude as to be capable of producing the more serious manifestations of plumbism, no amount of medical supervision and no quality of medical skill and judgment can be or should be expected to prevent the occurrence of lead poisoning. There are industrial physicians who believe they can anticipate the effects of dangerous lead absorption through the recognition of prodromal symptoms or incipient physical signs of intoxication. Others depend primarily upon early microscopic changes in the blood, of which an increase in the punctate basophilia of the erythrocytes is the most familiar, to give warning of impending saturnism. The usefulness of such measures, when employed with skill and with a background of experience, cannot be denied, but they have serious defects in principle and in practice, the elucidation of which would require prolonged discussion and illustration. Suffice it here to say that they should be employed primarily to demonstrate the existence of significant lead exposure rather than to provide means for avoiding the consequences of dangerous conditions that are permitted to continue.

A digression may here be justified to suggest that it is not the responsibility of the industrial physician to find a means for preventing the occurrence of intoxication among workmen who are known to be dangerously exposed to lead compounds. Nor is it his proper part to cover up the results of careless or unsatisfactory management of a plant and to forestall the worst effects of unsafe working conditions through the exercise of his skill in recognizing the imminence of disability just before it becomes awkwardly apparent. It is rather his function to understand the potential hazards of an occupation, to study and to interpret the consequences of exposure to such hazards, to inform the management, and to serve the employees in so far as they suffer from occupational conditions. Satisfactory exercise of this function requires familiarity with plant processes and operations as well as knowledge of the status of the health of employees. Thus periodic plant

inspections as well as periodic physical examinations are required, and careful clinical investigation of all types of illness is necessary. The periodic examinations should be thorough and detailed in their search for symptoms and signs of incipient intoxication, and should be augmented by suitable hematological studies, the extent and frequency of which should be determined by the severity of the exposure. Under favorable conditions of plant operation this type of supervision, among other benefits, will provide a necessary check upon the adequacy of the means employed to maintain the exposure within the limits of safety.

2. *Determination of the lead content of the air in working spaces.* For a variety of reasons which need not be discussed here, the control of respiratory exposure to particulate lead compounds is the most necessary single requirement for the prevention of occupational plumbism. It is of the greatest importance, therefore, that satisfactory methods be available for the determination of the lead content of the atmosphere of work-rooms, and that there should be acceptable standards by which to gauge the hazard in terms of such determinations. In a very practical sense, both methods and the means for their interpretation have been provided. Concerning the methods, little need be said, in view of the detailed descriptions of standard procedures which are available (1, 2). It must be recognized, however, that these methods have their technical and practical limitations and that they must be carried out intelligently and precisely if they are to yield useful information. Rough estimations of the lead content of the air at ill-chosen points in a plant and at inopportune times can yield only misleading information. As to the significance of the results, Legge and Goadby in 1912 concluded from their studies that if the air breathed "contains less than 5 milligrams per 10 cubic meters of air, cases of encephalopathy and paralysis would never, and cases of colic very rarely, occur." More recent workers have set the threshold value of toxicity at a somewhat lower level (3, 9, 11, 13) and there is abundant direct and indirect evidence for the belief that the inhalation of from 15 to 2 milligrams of lead per day is hazardous and will cause lead poisoning in a considerable proportion of individuals. Obviously, therefore, the lead content of the air breathed by workmen should be kept below this level. Atmospheric conditions in plants should be checked from time to time, and the effect of changes in equipment or in plant operation should be subjected to critical examination.

RECOGNITION AND PREVENTION OF LEAD POISONING

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IT has long been known that many substances may have a harmless—perhaps beneficial—effect upon the animal organism when absorbed into the body in small quantities, and an injurious or lethal effect when absorbed in larger quantities. With the recognition of the practically ubiquitous occurrence of lead in the soil, in food materials, in beverages, in animal tissues, and in the tissues and excreta of human beings, it has become apparent that lead belongs in this group of substances. The character and magnitude of normal lead metabolism have been described elsewhere (4, 5, 6, 7, 8, 11), and there is no need to discuss them in detail, here, but the practical importance of the facts in relation to the recognition of dangerous lead exposure and to the diagnosis of lead intoxication must be emphasized again and again, until it is fully appreciated.

This is not to imply that the behavior of lead compounds in the animal organism is fully understood, nor that the line of demarcation between safe and dangerous lead absorption is as sharply defined as might be desired. Nevertheless, it is safe to say that the knowledge now available, if applied in controlling lead exposure in industry, would reduce occupational lead poisoning almost to the vanishing point. Moreover diagnostic procedure can now be placed so securely upon a physiological foundation that many of the reasons for previous errors in judgment have been eliminated.

The prevention of lead poisoning in industry depends primarily upon the recognition of dangerous lead exposure. There are few types of occupational lead exposure that offer insurmountable or even difficult obstacles to modern hygienic and engineering safeguards. The ingestion of lead on the part of industrial workers can be, and has been prevented in the main by adequately equipped and supervised washroom, locker room and lunchroom facilities. Successful application of these safeguards requires careful supervision, for they can no more be left to chance or to individual performance than can any other plant procedure that calls for precision. Inhalation of fumes and dust—a much more significant type of

exposure—can be maintained within safe limits by properly designed and carefully operated general and local ventilating devices, augmented as required by intelligently chosen respirators. For a variety of reasons, the latter are less desirable and less dependable than other ventilating equipment, and their effective use demands detailed care and attention on the part of employee and management alike, but there are situations where they can hardly be dealt with otherwise. Cutaneous absorption which is of insignificant proportions in all lead trades except those which involve possible contact with certain highly fat soluble organic compounds such as tetraethyl lead, can also be avoided through the use of impervious coverings for the skin. In short dangerous lead exposure can be eliminated provided it is recognized as such and provided there is an adequately directed and sustained effort to do so.

There are, of course, inherently dangerous occupations in trades in which lead compounds and other poisonous materials are handled. Accidents and unforeseen operating difficulties inevitably produce serious hazards from time to time. These can be reduced to a minimum only through the exercise of skill and foresight, and they may be regarded with some degree of philosophic complacency as the natural consequence of the activities of a highly inventive and industrialized population. Although the frequency and the seriousness of such occurrences are likely to bear a fairly direct relationship to the degree of complacency with which they are accepted, they are not of primary importance in the lead trades. In such trades the factor of safety over any considerable period of time depends upon the magnitude of the lead exposure associated with the average normal operating conditions in the plant. The real problem, therefore, consists in knowing the magnitude and the hygienic significance of this basic or ordinary exposure.

Three general methods are available for the recognition of hazardous lead exposure. No one of these methods is wholly adequate for the purpose, but each has a practical and useful place in a successful scheme of plant control.

1. *Medical supervision of workmen.* A carefully maintained clinical study of the population of a plant or an industry will serve to establish the significance of the exposure to lead compounds.

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3. *Measurement of the lead excretion of exposed workmen* Studies of the lead excretion of workmen with various types and degrees of lead exposure have shown a definite correlation between the rate of lead excretion and the severity of lead exposure (9-11). The alimentary lead output of persons exposed to particulate atmospheric lead consists largely of that which has been entrapped in the upper respiratory passages, swallowed, and passed through the alimentary tract unabsorbed. Thus the analysis of suitable fecal samples obtained from workmen who represent the various occupations of a plant will give a cross-sectional picture of the exposure associated with their work for the day or 2 days immediately preceding that on which the samples were obtained. The lead content of adequate samples of the urine of these workmen will show the general magnitude of their lead absorption over a considerable period of time. The combination of these data will portray the lead hazards of a plant in terms of the physiological response of the persons who have been exposed to these hazards.

From the viewpoint of the physician, the advantages of this type of information are obvious. The presence of lead in the environment of a worker in atmosphere or otherwise, may or may not be important, but the presence of abnormal quantities of lead in the body of a workman is always important and must be explained. It matters little whether the particles of lead compounds suspended in the atmosphere of a plant are large or small, soluble or insoluble; that the atmospheric lead content is said to be within safe limits or that respirators are believed to be used correctly and faithfully or that other hygienic regulations are believed to be observed adequately, if the men are found to be absorbing significant quantities of lead in the course of days or weeks or months of work. On the other hand, if their lead excretion remains within safe levels, groups of men whose occupational exposure is potentially dangerous may be known to be working in actual security. Moreover the same analytical facilities that furnish information as to occupational lead exposure will aid effectively in the prompt solution of diagnostic problems. An analysis of a sample of blood and a sample of urine may disclose the occurrence of a wholly unexpected episode of lead intoxication, or it may rule out lead absorption and thus lead to the recognition and proper treatment of some other disorder (10).

It may appear that a study of the rate of lead excretion of representative workmen in a lead trade is an impractical means of plant control, and that this type of work should be devoted, pri-

marily, to the accumulation of scientific information. Actually, some experience with the difficulties encountered in industrial practice has convinced me to the contrary. It is especially difficult to interpret minor and incipient ailments and to handle them and plant problems that arise from them, with such assurance and sound judgment as will promote and merit the confidence and co-operation of both workmen and management. Errors in judgment are inevitable unless one has the best available means for testing his conclusions and such errors may be costly far beyond their immediate and tangible consequences. Moreover, it is not easy to demonstrate the need for preventive measures, which may add appreciably to the manufacturing costs of an industry without evidence which is comparable, in its applicability and its precision, to that habitually required by technical men and industrial executives in justification of major expenditures. Such evidence can best be provided by data on the extent of the lead absorption and excretion of exposed workmen. This is not to imply that measurements of the lead content of the air of workrooms are not useful, but rather that they are less useful, especially to the physician, than information derived from the actual study of the plant population.

It is not the purpose of the foregoing paragraphs to present a comprehensive and detailed program for hygienic control in industries in which lead exposure occurs. Neither are they designed to urge the adoption of any one measure for the recognition of significant lead exposure. The seriousness of the problem of occupational lead poisoning in present day industrial activities, and the difficulties associated with the maintenance of safety in potentially hazardous occupations, do not warrant any undue enthusiasm or professional predilection for any one method. Industry needs intelligent and skillful medical supervision, the most satisfactory methods for the recognition of dangerous lead exposure and the most effective technical devices for the maintenance of such exposure within safe limits. In short it will require the combined application of the best available chemical, toxicologic, and engineering facilities to provide an adequate solution of this hygienic problem.

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and suture are indicated in such wounds. It may be necessary to include the rib above and the rib below the wound in the sutures in order to maintain approximation. Hemorrhage from the intercostal and mammary vessels may require exposure and ligation, and it may be necessary to encircle the rib with the suture, both distal and proximal to the wound, to control bleeding.

Lacerated and contused wounds of the lung and gunshot wounds that involve the periphery of the lung do not require special treatment except the treatment of hemothorax, pneumothorax, and traumatic empyema, which will be discussed later.

Stab wounds, if sucking in character, are closed by suturing the injured lung to the parietal pleura following the method of Stenbuck and Connors. If near the margin of the sternum and if the pleural space fills rapidly with blood, the wound is explored and the blood vessels are ligated and the suggestions of Stenbuck and Connors are carried out.

Pneumothorax may be of all degrees from a slight amount of air which is absorbed rapidly, to a tension pneumothorax resulting from a valve-like wound sufficient to displace the mediastinum and gravely embarrass respiration. The most dangerous type is that resulting from rupture of the lung without any demonstrable injury of the rib cage.

Tension pneumothorax must always be suspected if cyanosis occurs early and may be diagnosed by bedside roentgenographs. Such patients often have multiple injuries, and a fractured skull or a distended, tense abdomen may claim the surgeon's attention. If the percussion note causes even the slightest suspicion of pneumothorax, a needle should be inserted. First rule out diaphragmatic hernia by roentgenograph, then if air is encountered under tension, leave the needle in place with a rubber tube leading over the side of the bed with the end of the tube placed under water, 2 or 3 feet below the level of the chest. Occasionally pneumothorax is bilateral. Dyspnea and cyanosis always call for action, and a roentgenograph of the chest.

Hemothorax follows all injuries to the thorax in some degree. If the bleeding is from the chest wall, the intercostal vessels, the internal mammary, or the azygos veins have been injured. Hemorrhage is the most common cause of death during the first 24 hours. If the wound is near the sternum or in the region of the posterior angle of the ribs, inspection of the wound and ligation of the vessels may be necessary. If shock is extreme and any operative procedure is contra-

indicated, a small proctoscope may be inserted through the wound and a gauze pack inserted, and pulled tightly against the internal surface of the chest wall to control the hemorrhage. If the bleeding is from a lung, the compression produced by hemothorax and pneumothorax usually is sufficient to control hemorrhage, particularly if the bleeding is from the periphery of the lung. If large hilar vessels or mediastinal vessels are injured, death occurs early.

The blood removed from the pleural space, unless macroscopically contaminated, may be filtered and an autotransfusion performed. The blood in the pleural space tends to become defibrinated by the churning of the lung and does not clot readily.

There is some difference of opinion as to the correct time to remove blood from the pleural space. Undoubtedly the best plan for those not familiar with chest surgery is not to aspirate the blood unless it is disturbing respiration to the point where relief is required. The blood may be safely aspirated 3 to 5 days following the accident. Cultures should be made and if infection is present then one of 3 courses may be followed:

1. Thoracotomy and removal of all clots from the pleural space, flushing with Dakin's solution or some other mild antiseptic solution, and closure of the wound without drainage, to be followed by frequent aspirations.

2. Closed tube drainage and tidal irrigations

3. Daily aspiration and, as soon as frank empyema develops, resection of a rib and institution of closed tube drainage. The first procedure, if done promptly and thoroughly, undoubtedly prevents many contaminated collections of blood from becoming empyema.

Diaphragmatic hernia may be operated upon much earlier than is the practice in most clinics. As soon as the patient has become adjusted to the changed condition, when the shock has subsided and the body fluids have been replaced, the hernia may be repaired. If organization of adhesions and atrophy of the flaps of the diaphragm have taken place, the procedure is much more difficult for the surgeon and far more trying for the patient. Crushing of the phrenic nerve on the side of the hernia is a valuable pre-operative procedure.

Traumatic subcutaneous emphysema usually does not require treatment other than the occasional release of tension as near to the injured rib as possible, or the passage of a moderate size needle into the chest and the release of air from the pleural space. Very occasionally it may be necessary to suture a rent in a lung or remove a fragment of the rib from the lung.

INJURIES OF THE CHEST AND ABDOMEN

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A RELATIVELY high percentage of the fatal accidents occurring in industry and in transportation results from injuries of the chest and of the abdomen, and their various complications. The immediate result of an injury of the chest may so embarrass the vital functions of respiration and circulation that death may occur within a few minutes and many accidents result in such extensive injuries that death results regardless of treatment. Judging from the records of autopsies some of our traumatic surgeons are of the opinion that about 10 per cent of the deaths which resulted from chest injuries might have been prevented.

Our automobile manufacturers spend large sums in the investigation of accidents and in the means of preventing them. The present automobile steering wheel is so designed that it crumbles into small pieces or bends when struck forcibly by the body of the driver. The old wooden steering wheels and wooden spiders were a constant menace, and caused many puncture wounds of the chest and abdomen. Similarly the development of shatter proof glass and other new features of modern automobiles have been designed with safety as the objective.

The more common injuries and their complications are (1) fractures of the bones of the thoracic cage (2) contused and lacerated wounds of the lungs (3) contused and lacerated wounds of the chest wall (4) gunshot wounds and stab wounds of the chest (5) pneumothorax (6) hemothorax (7) diaphragmatic hernia (8) traumatic subcutaneous emphysema, (9) traumatic empyema (10) pulmonary abscess.

The less common injuries and their complications are (1) cardiac contusion and laceration (2) hemopericardium (3) traumatic chylothorax (4) gangrenous pneumonia.

Undoubtedly pleural reflex and air embolism result from injuries of the chest but those conditions will not be discussed in this paper.

The two symptoms of greatest importance are dyspnea and cyanosis. Shock of an alarming character occurs following most injuries of the chest. Unless dyspnea or cyanosis develops along

with the shock, the outcome usually is favorable. A certain degree of shock is desirable. While the shock is present the hemorrhage from the injured soft parts often subsides and remains controlled unless too active therapy is instituted. Intravenous administration of fluids and therapeutic agents which raise the blood pressure are contra-indicated. Primary shock undoubtedly is one of the very best friends of the surgeon and the injured individual. This is not true of the long continued primary shock or of the prolonged secondary shock. Shock is the attempt on the part of the organism to control hemorrhage and were it not for this phenomenon, exsanguination would result from an injury of a small artery or a slight laceration of the lung, of the liver, spleen or kidney. Normal saline solution administered intramuscularly, heat, relief from pain and the Trendelenburg position are indicated as a safe routine of treatment.

In caring for fractures of the bones of the thorax there are 3 conditions which require special attention.

1 Depressed ribs, especially if the fragments are driven into the lung. The depressed portion of the chest must be elevated, and usually that is sufficient to release the lung. Under local anesthesia or often without any anesthesia the ribs may be grasped with towel clips and pulled into position and maintained there if need be by attaching towel clips to a weight hung over the side of the bed.

2 The sternum may be fractured free from all of the ribs and on inspiration be depressed thus interfering with both respiration and cardiac action. The sternum may be grasped with towel clips, or a screw may be inserted into the central portion and the sternum be held in position manually or by a weight attached to a frame over the bed or to a metal or wooden cradle placed over the chest.

3 A section of the rib cage may be fractured anteriorly and fractured posteriorly and the intermediate portion of the chest wall become depressed during inspiration. This condition requires traction in the same manner as previously described.

Lacerated wounds of the thoracic wall, if sucking in character, must be closed by strapping with adhesive over moist towels. Early debridement

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cent of these patients. When the shock is severe, an extremely painful injury, severe crushing injuries, and hemorrhage are responsible. Shock is very slight and often is absent in the solitary ruptures of the intestine or of the urinary bladder.

2. Vomiting is frequently not present and seldom contains blood. Vomiting often is delayed until septic peritonitis has developed.

3. The pulse is quickened; when extremely fast it indicates hemorrhage. The rapidly rising pulse rate and the falling blood pressure indicate active hemorrhage.

4. Temperature is normal or often subnormal immediately after an accident.

5. Respiratory movements of the abdomen may not be restricted, and the thoracic type of respiration often is delayed until contamination is general or until septic peritonitis has ensued. In ruptures of the stomach and upper intestine, the contents are very irritating, and a scaphoid, rigid abdomen and thoracic type of respiration are found immediately on examination. The contents of the colon are much less irritating and the spread is relatively slow. Distention is not present until late when peritonitis has caused paralytic ileus. Peristalsis may not be changed at first, but usually is restricted.

6. Rigidity may be absent, particularly in this true in injuries of the lower bowel and ruptures of the bladder. Peritonitis confined to the true pelvis usually is associated with very slight abdominal rigidity because of no parietal peritoneal involvement. The contents of the lower bowel are less irritating than those of the stomach and duodenum.

7. Local tenderness is not remarkable earlier and often is demonstrable only by rectal examination and by percussion.

8. Localized dullness, when present, indicates a confined hemorrhage in the mesentery, in the omentum, or in the retroperitoneal area. Free blood in the peritoneal space seldom is demonstrable even when a considerable quantity is present. A feeling of soft resistance by rectum will be given by a collection of blood in the pelvis.

9. The absence of liver dullness is not a reliable sign for pneumoperitoneum, but a tympanitic area above the liver in the midaxillary line and below lung resonance is indicative of pneumoperitoneum.

10. Rectal examination must never be omitted, early peritoneal tenderness may be elicited only by rectum. In retroperitoneal ruptures of air-containing viscera, emphysema of the pelvic cellular tissues may be palpated. In one patient a retroperitoneal rupture of the duodenum produced

pelvic emphysema, easily palpated by rectum, when the patient was first examined 17 hours after the accident.

11. Pain is the most important symptom and is present in some degree in all conscious patients. Constant, although perhaps very mild at first, it tends to increase gradually. Such pain sometimes is referred to the back and to the supraclavicular triangles when the peritoneum of the diaphragm is irritated. Following retroperitoneal rupture of the duodenum, there is pain in the back and in the testicles. With rupture of the bladder there is pain across the lower abdomen which seldom is severe and often is mistaken for the pain that is believed to result from contusion of the abdominal wall.

12. Frequent, complete blood examinations must be made. Slow, continuous bleeding soon shows a reduction in the red blood cell count and in the hemoglobin. Such changes often show in as short time as 1 or 2 hours. Bleeding in any space or in any tissue causes leucocytosis, often as much as 30,000 to 60,000 white blood cells. In shock, the peripheral concentration of blood gives a high red blood cell count and a high hemoglobin index.

13. Roentgenographs of the abdomen are indispensable. Ruptures of the diaphragm, blotting out of kidney shadow by hemorrhage, pneumoperitoneum, and emphysema of the posterior abdominal wall are conditions which may be revealed. It is well to have one film with the patient sitting up or at least turned on the side. Neopex injected intravenously may help locate the injury in the kidney, along the ureter, or in the bladder, and may indicate the extent of the injury. Also it may demonstrate which kidney should be explored when contusions are bilateral and either kidney may have been injured.

Diagnosis is always difficult in the patient who is most helped by intervention. Frequent examination and rechecking of the findings and of the laboratory work are essential if the best results are to be obtained. Continuous abdominal pain and increasing tenderness must not be relieved by sedatives without a full realization of the conditions which may be causing the distress.

The prognosis in all abdominal injuries is grave. Pollard reported 56 cases of which 17.85 per cent died within the first 5 hours, 32.14 per cent died within 5 to 25 hours, 33.94 per cent died within 24 to 48 hours, 16.07 per cent died within 3 to 16 days. This latter group of 16.07 per cent contains the patients in whom we are most interested. Surgical intervention, early, in these patients may be rewarded by many recoveries. In this

Pulmonary abscesses following stab or gunshot wounds are drained easily if the treatment as outlined by Stenbuck and Connors has been instituted. Following their procedure general empyema is much less likely to occur.

Cardiac lacerations necessarily require early treatment. Most cardiac lacerations produce death before the patient arrives at the hospital, but in patients where the injuring instrument has also torn the pericardium so that the blood escaping from the heart freely leaves the pericardium and enters the pleural space recovery may follow exploration and suture. Mattress sutures of fine Pagenstecher material are most useful, as Pagenstecher material is handled and tied easily. Even though suturing is successful a high percentage of heart wounds terminate in death from infection.

Hemopericardium usually is not seen sufficiently early to be relieved. Roentgenograms give us our best and earliest evidence. Occasionally when there is gradual oozing from the chest wall or from a small vessel on the surface of the heart aspiration will benefit and exploration and hemostasis may be indicated to control the hemorrhage. In traumatic chylothorax, aspiration usually is all that is indicated.

Gangrenous pneumonitis usually is fatal, but if only a small portion of the lung is involved drainage and removal of the separating slough may bring about recovery.

The diagnosis in all of the conditions mentioned is dependent upon careful examination, and the proper evaluation of the findings. Most of these patients have other injuries, of head, abdomen, or extremities. It is almost impossible to be certain of any physical findings. The recent refinements in the portable roentgen units have been most valuable to the traumatic surgeon. Excellent films may be made at the bedside and many of the conditions that were merely suspected are now diagnosed early. A drop in the mortality rate is certain to be the result.

Tetanus antitoxin and a full therapeutic dose of polyvalent anaerobic serum should be given in all lacerations of the chest and lung.

INJURIES OF ABDOMINAL VISCERA

The remarkable fact of the absence of all symptoms indicating a mortal injury for up to and of 2 hours' was the observation of Pollard in 1858. This observation is still timely and to be borne in mind when caring for the present-day industrial accident and the auto accident injury. We should always remember that the 2 hours may be lengthened to 6 or 8 hours under conditions of shock and alcoholism.

Surgical intervention often is delayed because of the following factors:

- 1 The injury does not seem serious to the patient and the medical advisor is not called until hours or even days following the accident.

- 2 The frequent absence of visible evidence of injury of the anterior abdominal wall leads the patient and the doctor to disregard the early mild symptoms of perforation of a hollow viscus.

- 3 The symptoms at the first examination are not remarkable, and frequent observations and examinations are not made.

- 4 Shock and alcoholism interfere with the usual reactions to serious injury on the part of an individual.

Battle, in the *Lancet* of 1919, made this pertinent statement: "It requires firmness to induce the patient to submit to an operation before peritonitis has made the need for operation obvious to the patient's friends." Vance stated, "Injury to the hollow viscera is often solitary, and complications develop insidiously. Death is from peritonitis rather than from hemorrhage."

The frequency of the injury of intra abdominal viscera during the pre automobile period given by Makins in 1899 was: kidney, 39+ per cent, intestine, 23 5+ per cent, bladder, 5+ per cent, mesentery, 3+ per cent.

Pollard located the injuries of the intestinal tract in 123 cases: duodenum, 6 cases, jejunum, 44, ileum, 38, mesentery 31 and colon, 4. Fifty eight per cent of the injuries were in the first 3 feet of the jejunum and the terminal 3 feet of the ileum. Bacon and Le Count reviewed 384 autopsies: all automobile accident injuries, and found the liver involved in over 50 per cent.

The viscera may be injured in the following manner:

- 1 Crushing of the viscus between the offending instrument and the bodies of the spine or other parts of the skeleton.

- 2 A tangential force moving the bowel beyond its limits of mobility may result in tears of the mesentery and tears in the intestine near the fixed portion.

- 3 Compression of fluid or gases in a single loop of intestine or in the bladder, which forces the wall to give way at the point of least resistance.

- 4 Fragments of the pelvic bones may rupture the bladder or the rectum.

- 5 Compressed air or water under pressure entering the anus may produce rupture of the rectum of the colon or of the stomach.

Symptoms. In the presence of abdominal injury the following symptoms are mentioned:

- 1 Some degree of shock is present in 80 per

ent, and exploration should be performed if these symptoms persist.

Surgical intervention in many of these patients cannot be considered. The injuries are extensive and multiple and the shock is extreme. Many come out of the shock under proper treatment and become fair operative risks. The high mortality must not close our eyes to the few who recover following surgical intervention. Builly reported the first operation for rupture of the intestine in 1883. The first successful operation was reported by Moty in 1889.

In exploration of the abdomen, complete relaxation on the part of the patient and an ample incision are essential. If free, uncontaminated blood is encountered it may be dipped out with a small ladle or aspirated, citrated, and run back into the patient's vein. Autotransfusion is a very valuable procedure. The small intestine is to be inspected carefully in a systematic way beginning at the duodenojejunal angle and proceeding to the ileocecal valve. It is very easy to overlook small perforations, so it is always well to instruct nurses as well as the assistants to watch closely. The stomach and colon are to be examined. Ruptures of the stomach are usually in the anterior wall and are easily found. Rupture of the duodenum is infrequent but swelling, bile discoloration, and emphysema in the region of the duodenum indicate a retroperitoneal rupture. The duodenum is easily mobilized by cutting the peritoneum to the right of the descending portion and rolling the duodenum to the left. If a retroperitoneal tear is present it is easily found and sutured.

An unusual rupture of a hollow viscus following crushing injury of the abdomen is a tear in the anterior wall of the rectum. The crushing may have been in the upper abdomen and the tear a

result of explosive forces produced by the compression of the gases in the lower colon. Such a condition was found in 2 patients, in 1 it was found during autopsy, and in the other it accompanied a rupture of the small bowel. Both latter injuries were repaired and this patient recovered.

The method of closure of any rupture of the intestine is not so important as long as the bowel is not constricted and there is not great tension on the sutures. Most openings in the small bowel are closed transversely. A double row of plain No. 0 catgut sutures are used in the bowel and the stomach, and three rows in the bladder. If there are many holes in a single loop, resection is simpler, and lateral anastomosis is always preferred.

Suprapubic drainage is always instituted in rupture of the bladder. If the extraperitoneal tears are small, free suprapubic drainage will prevent extravasation, and suture is not necessary.

The peritoneal space is never drained. It is almost impossible to establish peritonitis experimentally in animals unless some foreign material is left in—and a drain is foreign material. Multiple drains do not prevent general peritonitis but tend to provoke localized peritonitis and many adhesions. When the colon is ruptured retroperitoneally, a drain is always inserted into the retroperitoneal cellular tissues.

It is obligatory that all patients who have been through a serious accident be looked upon as seriously injured. The diagnosis may be made if we use all the diagnostic aids at our disposal and do not fall into the habit of pronouncing finally following one examination, and that examination made shortly after the accident. More and more are we becoming dependent upon the x-ray department for help in the early diagnosis of injuries resulting from trauma.

group are included the small perforations the mesenteric tears because of which the intestine later may slough, the contusion of the bowel which later produces slough, the ruptured urinary bladder, and the ruptured spleen and kidney.

Curtis in 1887 remarked, "Recovery after a rupture of the intestine is a surgical curiosity." The same year Curtis conducted 44 experiments in which the abdomens of anesthetized dogs were contused with the following results: 13 lacerations of the mesentery severe enough to deprive the intestine of its blood supply, 16 contusions of the bowel without perforation but likely to slough later, 8 ruptures of the bowel, 2 of which were multiple. The danger from mesenteric tears is not generally appreciated. Such patients are observed until the bowel sloughs and peritonitis develops before intervention is considered. Disturbances in the blood supply from the mesenteric tears, not extensive enough to cause sloughing, may produce lymph stasis and round cell infiltration of the bowel, followed by fibrosis. Such fibrosis producing partial or complete obstruction, possibly explains some of the conditions diagnosed as cicatrizing enteritis.

Rupture of the liver, of the spleen and of the kidney always must be suspected following an injury where great traumatizing force has been expended. An injury of the kidney may be slight such as subcortical tears or contusions producing a few red blood cells in the urine. The increase of pain in the flank and the persistence of bloody urine should suggest that a laceration of the kidney may be present. Perirenal hemorrhage usually displaces the ascending or descending colon toward the midline. If the bleeding continues and the patient shows evidence of blood loss exploration of the kidney is imperative. When it is difficult to rule out intra abdominal injury exploration through a transverse incision beginning at the edge of the rectus muscle and extending into the flank is the incision of choice. It is very easy to remove a kidney through this type of incision. The kidney is retracted toward the abdominal aorta, tending to relax the pedicle rather than away from it as in the nephrectomy, through a posterior incision. Following the removal of one kidney I have been rather reluctant to give a transfusion because anuria has occurred twice following such transfusions.

Rupture of the urinary bladder happens much more frequently than is generally believed. Rupture may cause few symptoms and in the presence of multiple injuries of the soft tissue or injury of bone is so easily overlooked. It is an order in the San Francisco Emergency Hospital Service that

every deeply alcoholic or shocked patient who comes into the hospital shall be catheterized as soon as possible. Less than 5 per cent of the ruptures of the bladder are caused by fractures of the pelvis and 40 per cent result from automobile accidents. The remainder are produced by crushing injuries and falls.

It is not unusual to inject 300 cubic centimeters of saline solution into a bladder which has been ruptured and remove 700 cubic centimeters or more of fluid. In such patients the catheter sticks through the rupture in the bladder and siphons out urine and saline which are free in the pelvis. Several patients have voided bloody urine when roentgenographs showed that urine was free in the peritoneal space. The test that should be used in all of these patients is this: if the urine contains blood or no urine is removed by catheter, inject 500 cubic centimeters of 5 per cent sodium iodide solution, and make a roentgenograph. This will show if the solution is confined in the bladder. Air may be found under the diaphragm if there is an intraperitoneal rupture of the bladder and air has been injected into the bladder. Five to 8 hours after injury the bowel, omentum or the edges of the wound may adhere closing the bladder temporarily, and thus the sodium iodide may be confined to the bladder.

The treatment of rupture of the liver if it is possible to rule out rupture of the kidney and of the spleen, is expectant. Bleeding from large lacerations of the liver may cease if the patient is allowed to remain in a state of low blood pressure and complete rest. Intravenous administration of fluids, heart stimulants, and agents which raise the blood pressure are contra-indicated. If exsanguination is imminent, blood transfusion must be performed. If exploration is performed bleeding from the liver may be controlled by compressing the hepatic artery and the portal vein in the gastrohepatic omentum between the index finger and the thumb with the index finger in the foramen of Winslow. A springy gastro-intestinal clamp the blades guarded with rubber tubing may be used for compression of these vessels.

Unless the spleen is comminuted, hemorrhage is slow and often 3 or 4 days pass before exsanguination is threatened. The leucocytosis upper abdominal distress pain in the supraclavicular regions and the constant drop in hemoglobin should suggest intra abdominal bleeding. The rhythmic contractions of the spleen squeeze out the clots and thus cause recurrent hemorrhage. Tears in the mesenteric vessels are difficult to diagnose but the signs of intra abdominal hemorrhage and continual abdominal distress are pres-

centralized first aid stations or dispensaries are desirable in order to insure adequate treatment and records

When hospital services are needed by an industrial organization it is urged that it draw upon existing facilities for such service wherever possible. Very few sections of the country at the present time are so remote as to be inaccessible to an approved hospital. Industrialists will find that in the long run they can obtain more efficient hospital service at less cost from organizations whose sole purpose is to conduct hospitals than they could by establishing their own hospitals

SCOPE OF THE MEDICAL SERVICE

Half-way measures will bring only partial results. On the other hand, a too extensive medical program may be so burdened with unnecessary frills and unappreciated paternalism that the end-results will not justify the costs. The following outline for the scope of an industrial medical service has been proved effective and adequate in many industrial organizations and its further adoption is urged:

1. *Pre-employment physical examinations* The purpose of pre-employment physical examinations is to ascertain the physical status of prospective workers in order to facilitate the placing of such workers in positions for which they are best or at least suitably fitted. These examinations should be made of all, regardless of whether they are office or shop workers. The examinations should be made only by qualified medical examiners and the records thereof should be filed in the medical department under medical supervision and not in the employment department. A few employers are still using lay attendants for making physical examinations of employees. The folly thereof is evident.

The question of doing routine Wassermann or Kahn tests on all new employees is now a current one. Some of the large industrial organizations are making such tests just as much of a routine procedure as is the use of the stethoscope in examining the heart. Workers, whether new or old, who have syphilis are usually permitted to work in either selected or their usual positions provided they are receiving adequate treatment.

The principle involved in taking an inventory of the human machine before employment is sound. When properly done, it is profitable to employer and to employee, and within the next 5 to 10 year period pre-employment physical examinations will no doubt become a standard practice for all industrial organizations. After reviewing thousands of physical examination

record forms used in industry, the College has recently formulated a short series of such record forms which provide space for recording the essential data that are desired. Samples of these record forms may be obtained by writing to the American College of Surgeons.

2. *Periodic health examinations.* The purpose of periodic health examinations is to aid in maintaining the health of the worker and to further assure the compatibility of placement with the health of the worker and with the safety of others. Obviously these examinations should be done with sufficient thoroughness and frequency to permit of accurate diagnosis and early recognition of disease if the objective of "health maintenance" is to be accomplished.

A number of industrial organizations examine annually all of their employees from the plant manager down to the watchman at the gate, with more frequent examinations given to those who are exposed to occupational disease hazards. Others examine annually all of their employees over 45 years of age and every 2 or 3 years those under 45. Still others have placed the health examinations on a purely voluntary basis. Experience has shown that this latter practice is not as efficient as in those instances in which an orderly system plus voluntary examinations has been provided.

The industrial physician should serve as an unbiased but friendly counsellor to the employee, referring those who are found to have physical defects to their own private or family physician for treatment or follow up. Industrial physicians should never solicit private patients from among the workers whom they serve in the plant. To do so would not only be unethical but it would betray the employer and destroy the confidence of the employee in the medical service. Physicians should obtain their patients on merit alone.

The industrial physician by serving as a liaison between the employee, the employer and the private practitioners can create an alliance among the interested groups that will allay criticism and make preventive medicine more effective than any other procedure. Such an opportunity for preventive work should not be impeded.

3. *Prevention and care of all industrial injuries and occupational diseases.* The physician in charge should determine the presence or absence of occupational disease hazards in the plant. The services of a chemist or a laboratory worker may be required in order to determine the degree of the health hazard but the engineering department is charged with its control. Every effort should be made by the industrial physician to co-operate

THE MODERN CONCEPT OF THE INDUSTRIAL MEDICAL PROBLEM

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THE industrial medical problem has been and always will be fundamentally the same, namely, 'the adequate care of the health of the industrial worker'. Lack of information on the subject, lack of interest on the part of some employers, and inadequate workmen's compensation laws have been important factors in retarding a more widespread realization of what constitutes adequate care of the industrial worker's health. While the machine age and the more widespread use of toxic substances or processes in industry have made the health problem more complex, nevertheless the objective of maintaining the health of the worker has always been the same and the attainment of that objective should never permit of compromise.

ATTITUDE TOWARD THE PROBLEM

The defensive type of industrial medical service designed mostly to protect the employer and the purely curative type of service which were so prevalent in the past are fortunately fading out of the picture. Activated by costly experiences with industrial injuries and occupational diseases in the past, obligated by compensation laws which are gradually including occupational diseases, and enlightened more recently by publications and symposia on occupational diseases which have been held throughout the country, there seems to have been a general and more thorough awakening of employers and of the medical profession to their responsibilities for the care of the health of the industrial worker. There still are a few diehards, of course who have closed their eyes to occupational disease hazards in their plants or who do not report disabilities resulting therefrom simply because their state has not yet recognized occupational disease in their compensation law.

Many employers, however, have had a change of attitude. They are adopting a broader view point of the whole subject and are manifesting more of a protective interest in the health and working conditions of their employees. This is as it should be. Another encouraging situation is the fact that industrialists are now realizing that they

cannot cope with the employee health problems alone. Similarly the members of the medical profession are aware of the lack of sufficient scientific knowledge in regard to the toxicology of certain industrial materials and of the fact that further research in this field is required. With a co-operative attitude on the part of the employer, the physician or surgeon, the laboratory worker, the engineer and the worker himself the problems of occupational disease and health maintenance will be no greater than the control of the situation with respect to industrial injury in which so much progress has already been made.

ORGANIZATION OF THE MEDICAL SERVICE

Personnel. To secure the most efficient type of medical organization the industrialist should first of all employ a competent medical or surgical director. The management and the medical director together can formulate more practical policies and procedures for their health program than would result from independent action.

Co-operative interdepartmental working relationships should of course be established but the authority and responsibility for the selection of the first aid and medical personnel and for the direction and supervision of the medical service should be delegated to the medical or surgical director. Given these responsibilities, the medical director should then be expected to exercise his prerogatives and to produce results. Fixing the responsibility for the supervision of the medical service in competent medical hands and at one point is the most important step in the organization of the medical service. With this done accomplishment of the objectives is largely assured.

Obviously only competent medical and surgical assistants and consultants should be selected. The first aid attendants should be properly instructed and trained in their duties and their work closely supervised.

Facilities. The use of first aid kits in extremely decentralized industrial operations may be necessary but their unsupervised use in industrial establishments as a whole should not be permitted. Experience has shown that such use will bring more harm than good. Fewer and more

TABLE I.¹—ACCIDENTAL DEATHS IN THE UNITED STATES IN 1936

Total	111,000
Home	38,500
Motor vehicle	37,800
Public (not motor vehicle)	20,000
Occupational	18,000
Disabling injuries	10,750,000
Wage loss, property damage, medical expense	\$3,700,000,000

¹National Safety Council report

workers of \$2,000,000,000 per year at a wage rate of \$5 per day.

Respiratory infection (the common cold) is still the greatest cause of absenteeism. Since much of the absenteeism in industry is preventable, we then have additional tangible objectives toward which an industrial health program should be directed.

Accident fatalities There were 18,000 occupational deaths in 1936 as compared with 16,500 in 1935, an increase of 9 per cent. Death totals as caused by types of accidents, number of disabling injuries, and related costs are given in Table I as reported by the National Safety Council

MEDICAL AND COMPENSATION COSTS

In a study of medical costs made by the College, 299 industrial organizations representing 1,237,775 workers, reported a medical cost of \$5.11 per employee for 1936 as compared with a previously reported cost of \$6.30 per employee in 1932. The reporting companies bore all medical costs and maintained a minimum of a first aid room, an attendant—usually a graduate nurse, and doctors serving on call, or part to full time. The greater per capita cost in 1932 is partially explained by the fact that medical service, though reduced, was not curtailed as rapidly or as much as was employment during the depression period. Consequently, the medical costs were spread over comparatively fewer employees. Furthermore, the recent marked increase in number of workers in industry also accounts for the apparent reduction in per capita cost in 1936, when in reality the total medical cost would be considerably greater in 1936 than in 1932.

The gradual increase in annual per capita medical costs has not been an increasing burden on employers. On the contrary, this expenditure for medical service has effected far greater savings, by reducing labor turnover, by maintaining healthier, happier, and more efficient workers, by reducing accidents and occupational disease, and by reducing absenteeism in general. The per

TABLE II—PER CAPITA MEDICAL COSTS IN INDUSTRY

Year	Cost
1915 ¹	\$0.88
1917 ¹	2.21
1921 ²	4.43
1924 ²	5.14
1930 ²	5.10
1932 ³	6.30
1936 ³	5.11

¹M. W. Alexander²National Industrial Conference Board³American College of Surgeons

TABLE III.—MEDICAL AND COMPENSATION COSTS ACCORDING TO SIZE OF PLANT—1936

Number of employees	Number of companies reporting	Total number of employees	Medical cost per capita	Compensation cost per capita	Total cost per capita
1,000 & up	177	1,142,950	\$4.93	\$3.49	\$8.42
500-999	83	81,349	6.97	4.33	11.30
1-499	39	13,456	8.76	4.76	13.52

Source—American College of Surgeons

capita medical costs which range from 88 cents in 1915 to \$5.11 in 1936 are shown in Table II.

Costs by size of plant In the study of the 299 companies previously mentioned, the College found that establishments having 1,000 or more employees showed a per capita cost for medical and compensation purposes of \$8.42 as compared with a cost of \$13.52 for the plants having less than 500 workers (Table III). Better organization of the medical and safety services in the larger plants accounts largely for their lower costs.

Distribution of medical costs. According to reports from 268 companies that spent \$4,111,296.56 in 1936 for medical service for their employees, 63 per cent of this amount was paid to doctors and nurses, 15 per cent to hospitals, 13 per cent for administration, and 9 per cent for supplies. These employers maintain a minimum of a first aid room and a nurse, and doctors on call or part to full time, but they do not provide home medical care for employees or their families. The 13 per cent spent for administrative purposes is significant in that it reveals that employers are now, more than ever, willing to spend money for a "follow through" and support for their medical service and thereby obtain greater benefit from their program of health maintenance. It is urged that industrial physicians and surgeons recognize this trend and participate more actively in the administrative phase in order that the future voyage of industrial medicine and surgery may be better charted.

with the various departmental heads in the prevention of industrial injuries and illnesses.

The prevention of infection is still a problem in industry. In the state of New York 15 per cent of all compensated cases in 1932 were infected cases. Approximately 10 per cent of all occupational injuries compensated in 1935 were cases of infected wounds according to the reports of industrial commissions of 4 states. At this rate it has been estimated that compensation for infected injuries would total at least \$11,000,000 per year in the United States. Much of this cost might be saved if every injured workman were required to report promptly for proper first aid or medical treatment. The provision of the necessary care for industrial injuries is of course required of the employer by the workmen's compensation laws. Experience has shown that the best surgical and hospital service is the cheapest.

4 *First aid and advice for employees suffering from non industrial injuries and illnesses while on duty.* Reasonable first aid and advice may be given to employees who are suffering from non industrial injuries and illnesses while on duty. For further professional care however, such employees should be referred to their own private or family physicians. If the worker does not have a private physician he should be aided in selecting a competent one.

5 *Medical supervision of plant sanitation and of all industrial health measures.* The direction and supervision of the health program or medical service should be a duty of the medical director. Probably no phase of the average industrial medical service has been so badly abused or neglected as that of supervision of the medical service. Surveys by the College have revealed that while some of the larger industrial organizations have had proper medical supervision, most medical services are supervised by others than physicians or surgeons. If such logic is sound, we should then expect to find plumbers in charge of sales promotion work and advertising heads transferred to the foundry.

Fortunately, there have been some constructive changes, though gradual, in this respect and in the past year some of the largest industrial organizations in this country have employed competent physicians or surgeons to correlate and supervise their medical services. Adequate medical supervision will assure adequate medical service. The industrial physician of the future, however, must add administrative duties to his purely professional services.

Regulations for the first aid and medical service at the plant should be formulated and signed

by the physician in charge for the guidance of assistants and first aid attendants. Periodic visits should be made to the plant dispensary to see that such standing orders are enforced. Periodic inspection trips through the plant should also be made by the physician in order to ascertain working conditions, job requirements and the presence or absence of health hazards.

RECENT TRENDS AND EXPERIENCES

Injury rates. According to the report of the National Safety Council the injury frequency rate for all industries in 1936 was about the same as it was in 1935 but the severity rate increased 5 per cent in that period. From 1926 to 1936, however, there has been a decline of 61 per cent in injury frequency rate and 40 per cent in severity rate for all industries. The public utilities have made the greatest reduction in injury rates during this 10-year period. We should bear in mind that good medical service has been and can be responsible for approximately one third of the reduction in injury rates.

Occupational disease incidence. Approximately 1 per cent of the compensated cases in New York State during a 3 year period, 1933 to 1935 were awards for occupational disease. Other authorities are of the opinion that occupational disease accounts for approximately 2 per cent of the total disabilities from industrial causes. From 1935 to 1936 there was a 43 per cent increase in occupational diseases reported in New York State, whereas the total number of industrial injuries reported increased only 23 per cent in the same period. The length of disability caused by occupational diseases has averaged about the same as that caused by industrial injury.

Absenteeism. In a limited study made by the American College of Surgeons 116 companies in various parts of the United States employing 352,591 workers reported a loss of 208,648 days in 1936 on account of industrial injuries—a loss of approximately one half day per person. Included in these reports to the College, from companies in which quite accurate data are kept on absenteeism, were findings which showed that the average worker loses 15 times as much time from non industrial injuries and illnesses as he does from industrial injuries. Consequently if 50,000,000 workers in the United States lose 400,000,000 days annually on account of injury and illness this would represent a loss to the

¹ Allowance must be made for variation in the method of record keeping among various industrial organizations. If we were the statistical data submitted to the College are sufficiently accurate to show trends in either absenteeism or costs.

COMPLETE AVULSION OF THE SCALP AND LOSS OF THE RIGHT EAR

Reconstruction by Pedunculated Tube Grafts and Costal Cartilage

JAMES A. CAHILL, JR., M.D., F.A.C.S., and PHILIP A. CAULFIELD, M.D., Washington,
District of Columbia

WHILE scalping is commonly associated in the lay mind with the aborigines of our western plains, there is scattered anthropological and historical evidence to the effect that it was practiced regularly as an act of war even in the days of Herodotus, who himself described the custom as observed among the Scythians. Occasional explorers and travelers in Asia, Europe, and Africa have returned with fragmentary accounts of scalptaking by savage tribes as well as by certain barbaric races. Naturally, instances of scalping by uncivilized peoples were seldom or never reported in medical literature, hence our knowledge of the prevalence of the practice and the frequency of its employment prior to the mid-nineteenth century is based mainly upon the random references already cited.

However, coincidentally with the wider utilization of machinery in manufacturing, cases of accidental avulsion of the scalp have gradually become more numerous, until the term as at present employed is virtually synonymous with industrial scalping.

In his authoritative monograph on the subject of accidents by scalping published in 1911, John Staige Davis recorded a total of 92 cases of complete avulsion of the scalp from all causes, culled from an exhaustive study of the medical literature of the entire world up to that time, 81 of them by machinery. The first of these occurred in England in 1838 and was reported one year later by Downs. A girl of 17 caught her hair in a rapidly revolving horizontal shaft and was completely scalped, the line of tearing involving both eyebrows. Despite expectant treatment consisting in part of simple dressings and partly of dressings soaked in a weak zinc solution, healing was slow with smooth, flabby granulations, and a portion of the denuded parietal bone was exfoliated. The patient suffered from continued irritation and

discharge accompanied by cough and fever. Erysipelas finally developed, and death followed 8 months after the accident.

Four additional cases of complete industrial scalping were reported during the period of 30 years succeeding the failure recorded by Downs, and antedating the application of skin grafts for the repair of the resultant defect. In these cases, all in young women, healing was effected by cicatrization in 2 patients, while a third patient declined further medical care after 8 months of unsuccessful from simple bandaging, and died half a year later. The fourth patient succumbed to pneumonia and pachymeningitis on the 24th day following reattachment by silk suture of the avulsed scalp.

The art of rhinoplasty, the forerunner of our modern system of plastic surgery, was known to the ancients, as a reference to the procedure in the *Ebers Papyrus* (about 1500 B.C.) attests. However, the operation appears to have attained to its highest degree of perfection in antiquity among the Brahmans of India, who are said to have utilized for the purpose pedunculated flaps from the cheek and forehead and even to have attempted plastic surgery of the ears as early as the second century of the pre-Christian era. In his erudite study of the history of skin grafting, Ehrenfried relates that there were among the Brahmans certain individuals of low caste who specialized in the repair of the mutilated features of malefactors whose ears and noses had been amputated as a penalty for their crimes. Another procedure of these pioneers in plastic surgery consisted in castigating the skin of the buttock until it had become markedly congested, excising a portion of the skin together with its subcutaneous fat, transplanting it by uniting it to the previously freshened edges of the defect, and finally suturing in position.

After a long period of disuse, the practice of rhinoplasty was in the 16th century resumed in Italy, whence it was believed to have been imported by the Arabs. In 1597, Gaspar Tagliacozzi of Bologna, a skilled otorhinologist of his

From the Department of Surgery, Georgetown University School of Medicine

Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.

SURVEYS BY THE COLLEGE

During the past year the medical services of 1,657 industrial establishments representing approximately 5,500,000 employees have been under survey by the American College of Surgeons. Of this number 843, or 50 per cent have been provisionally or fully approved as of October 1, 1937. To those industrial establishments in which the medical service is fully approved and is of such a nature as to give reasonable assurance of continued compliance with the minimum standard, a certificate of approval is granted.

The number of new establishments added to the list for survey during the past year has not been as large as in former years. More attention has been directed to the organizations previously

surveyed in which there was not only the opportunity but an urgent need for constructive work.

The co-operation extended to the College by the various industrial organizations in this movement to make efficient medical service readily available in industry through effective organization has been most active and encouraging. Many constructive health measures for employees have been recently instituted by employers in order to care better for the human machine in industry.

No doubt this progress is a result of the growing realization on the part of industrial managements that the human element is the most important factor in the structure, operation and product of any industrial organization.

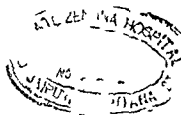




Fig 4



Fig 5



Fig 6.

Fig 4 View showing the narrow strip from the left side of the scalp which had been previously undermined and slid or transferred to the center of the scalp. This makes a definite bridge of scalp reaching from the occiput to the sinciput.

Fig 5 The first pedicled tube graft taken from the right

side of the back. The patient did not want the pedicles taken from the axilla or anterior chest. Probably this would have been a better location. However, this graft proved later to be quite satisfactory.

Fig 6. Pedicled graft attached at position of right ear in the right mastoid area.

of Ollier's effort to improve upon Reverdin's operation, and the fact that the method originally devised by him was appropriated with only slight modification by Thiersch, clearly entitle the name of Ollier to precedence in the hyphenated eponym Ollier-Thiersch adopted by a few medical lexicographers.

Eventual dissatisfaction with Thiersch grafts led in due course to the revival of the free flap according to the second Indian method, first by Wolfe of Glasgow in 1875 and later by Krause of Altona, who is credited with the establishment of the procedure in surgical practice in 1893 under the title of the Wolfe-Krause method. This was in turn succeeded by the renaissance during the latter part of the 19th century, primarily through Maas, of the method of the pedunculated flap obtained by one of the procedures already described, namely, French, Indian, and Italian (Tagliacotian). A modification of the latter method was utilized in our case of complete avulsion of the scalp.

Grafts for the treatment of complete scalping were employed originally in 1869 by Netolitzki, who transplanted small, elliptical shaped pieces of skin of whole thickness from the back of the hand of a female patient of 24 years. A colleague, Philipp, later attempted to transplant skin from

dogs and rabbits (zoodermic grafts) to the same patient. The lesion remained unhealed after 2½ years of treatment.

The use of Reverdin autodermic grafts for the treatment of complete scalping was essayed first in 1871, in the United States, by Bartlett, who applied them quite successfully to a woman aged 19.

This case, reported in 1872, only 3 years after Reverdin's original description of his method, apparently is the earliest recorded instance of total avulsion of the scalp treated by that method.

In 1889 Socin was the first to utilize Thiersch grafts (in conjunction with Reverdin grafts) in the treatment of complete scalping in a girl of 15. Healing ensued in his case after 10½ months.

The 96 cases of complete industrial scalping reported to date involved 95 females and 1 male (a Chinaman, whose queue was caught in machinery), the youngest aged 8, the eldest 63 years. Of these cases, 23 occurred in the United States. In 58 cases the line of tearing included one or both eyebrows, in 21 the line of tearing passed above the eyebrows, while in 17 the line of tearing was not clearly specified. The left ear was involved in 13 and the right ear in 12 cases, and in 1 case in which the ear is said to have been included the side is not stated.



Fig 1

Fig 1 Photograph showing complete area of scalp avulsion extending over the entire top of the scalp also complete loss of the right ear



Fig 2

Fig 2 Area of scalp avulsion with loss of right ear looking



Fig 3

ing laterally from right side. Note also that the petrium is visible

Fig 3 Area of scalp avulsion looking posteriorly at the occiput. Only a small portion of left side of scalp remains

time, introduced a modification of the usual operation, which had during the preceding century been monopolized by the Brancas a family of plastic surgeons of Sicily. In a formal treatise on the subject Tagliacozzi described what has since come to be known as the Italian (or Tagliacotian) method whereby the flap is obtained from a distant part, generally the arm and shifted to its new position by single or multiple transfer. This was in contrast to the earlier Indian method until then in vogue, in which the flap was obtained from the immediate vicinity of the defect and transferred to its new position by rotation on its pedicle. Tagliacozzi's method ultimately fell into disrepute and the practice of face repairing was subsequently condemned by ecclesiastic and medical authorities alike.

A third method of obtaining pedunculated flaps the so called French method originally devised by Celsus and developed especially by the French, hence its title, consists of the sliding of flaps from adjacent tissue with little or no torsion of the pedicle.

In 1869, Jacques Louis Reverdin proved that small particles of epidermis placed upon a granulating surface promoted healing and thus established his method of 'epidermic grafting' although as Reverdin himself pointed out, the designation was not entirely accurate since the

transplanted bit actually consisted of the whole epidermis and a very small part of the dermis. The method was at once adopted in several countries of Europe and even in America, and all went well with it at first. However, it was soon discovered that while Reverdin grafts expedited natural cicatrization they caused contractures especially in the region of joints.

In an endeavor to overcome these disadvantages, in 1872 Louis Ollier evolved his procedure of dermo epidermic grafting with films of epidermis containing a portion of the dermis much larger than those employed by Reverdin, pared off in strips and applied to the surface of a wound after shaving down the granulations. Unlike Reverdin Ollier did not seek to produce multiple centers of epidermization but to substitute for the integument of an ordinary cicatrix a surface possessing the essential elements of normal skin.

Ollier's method likewise enjoyed only brief favor and served chiefly as a basis for subsequent experimentation by Karl Thiersch who in 1874 reported tentative results obtained with his adaptation of Ollier's technique, the modified procedure involving merely the use of still larger pieces of skin of whole thickness from which the adipose tissue had been carefully removed. However it was not until 12 years later (in 1886) that Thiersch finally announced his perfected method which has since been known almost universally as Thiersch grafting. None the less, the priority



Fig 4



Fig 5



Fig 6

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This case, reported in 1872, only 3 years after Reverdin's original description of his method, apparently is the earliest recorded instance of total avulsion of the scalp treated by that method.

In 1889 Socin was the first to utilize Thiersch grafts (in conjunction with Reverdin grafts) in the treatment of complete scalping in a girl of 15. Healing ensued in his case after 10½ months.

The 96 cases of complete industrial scalping reported to date involved 95 females and 1 male (a Chinaman, whose queue was caught in machinery), the youngest aged 8, the eldest 63 years. Of these cases, 23 occurred in the United States. In 58 cases the line of tearing included one or both eyebrows, in 21 the line of tearing passed above the eyebrows, while in 17 the line of tearing was not clearly specified. The left ear was involved in 13 and the right ear in 12 cases, and in 1 case in which the ear is said to have been included the side is not stated.



Fig. 1

Fig. 1 Photograph¹ showing complete area of scalp avulsion extending over the entire top of the scalp also complete to 3 of the right ear



Fig. 2

Fig. 2 Area of scalp avulsion with loss of right ear looking



Fig. 3

ing laterally from right side Note also that the pericranium is visible

Fig. 3 Area of scalp avulsion looking posteriorly at the occiput Only a small portion of left side of scalp remains

time introduced a modification of the usual operation which had during the preceding century been monopolized by the Brancas, a family of plastic surgeons of Sicily. In a formal treatise on the subject Tagliacozzi described what has since come to be known as the Italian (or Tagliacotian) method whereby the flap is obtained from a distant part, generally the arm, and shifted to its new position by single or multiple transfer. This was in contrast to the earlier Indian method until then in vogue in which the flap was obtained from the immediate vicinity of the defect and transferred to its new position by rotation on its pedicle. Tagliacozzi's method ultimately fell into disrepute and the practice of face repairing was subsequently condemned by ecclesiastic and medical authorities alike.

A third method of obtaining pedunculated flaps the so called French method originally devised by Celsus and developed especially by the French, hence its title consists of the sliding of flaps from adjacent tissue with little or no torsion of the pedicle.

In 1869 Jacques Louis Reverdin proved that small particles of epidermis placed upon a granulating surface promoted healing and thus established his method of epidermic grafting, although as Reverdin himself pointed out, the designation was not entirely accurate since the

transplanted bit actually consisted of the whole epidermis and a very small part of the dermis. The method was at once adopted in several countries of Europe and even in America, and all went well with it at first. However, it was soon discovered that while Reverdin grafts expedited natural cicatrization they caused contractures, especially in the region of joints.

In an endeavor to overcome these disadvantages, in 1872 Louis Ollier evolved his procedure of dermo epidermic grafting with films of epidermis containing a portion of the dermis much larger than those employed by Reverdin, pared off in strips and applied to the surface of a wound after shaving down the granulations. Unlike Reverdin Ollier did not seek to produce multiple centers of epidermization but to substitute for the megument of an ordinary cicatrix a surface possessing the essential elements of normal skin.

Ollier's method likewise enjoyed only brief favor and served chiefly as a basis for subsequent experimentation by Karl Thiersch, who in 1874 reported tentative results obtained with his adaptation of Ollier's technique the modified procedure involving merely the use of still larger pieces of skin of whole thickness from which the adipose tissue had been carefully removed. However, it was not until 12 years later (in 1886) that Thiersch finally announced his perfected method which has since been known almost universally as Thiersch grafting. None the less, the priority

¹These photographs were made through the courtesy of Dr. C. J. and Le Bell, Washington, D.C. and acknowledgment is made herewith.



Fig 9



Fig 10.



Fig 11.

Fig 9 The large tube graft attached both anteriorly and posteriorly. The roll of full thickness skin hangs over the scalped area and requires the adhesive bridge which is plainly seen to secure it, as otherwise it might become detached. Note also the smaller of the tubes in place for the reconstruction of the right ear.

Fig 10 The roll or tube has now been opened and has been spread over the avulsed area.

Fig 11. Posterior view of the same tube roll. The scalp has now been fully covered.

Fig 12 Another view showing the skin *in situ*, the same having been more carefully attached by plastic procedure.



Fig 12

to the center, and held by catgut sutures. The entire area of operation was flushed with a 0.5 per cent chlorine solution, a large sheet of oil silk soaked in liquid paraffin was spread over it, and pressure was applied by a capeline bandage. By the seventh day the flaps were firmly adherent to the pericranium. No hairbearing flaps were destroyed, the hair grew well after 4 months, and the areas of granulation then appeared smooth and flush with the adjacent scalp. Mild doses of ultraviolet rays on alternate days for a brief period completed the cure.

Recorded instances of attempts to reconstruct a missing ear are exceedingly rare, perhaps because of the risk of infection of cartilage, with shrinkage consequent upon chondritis or perichondritis, the problematical cosmetic result, and the possibility of postoperative atresia of the canal. However, the revival during the world war of the use of the pedunculated flap, this time in the form known as the pedicled tube graft, rendered readily practicable the safe and satisfactory restoration of a traumatic auricular defect, primarily through the possibility by means of

this type of graft of transferring portions of cartilage which serve to impart stability to the softer structures involved in the molding of the ear. Lockwood, a pioneer in the introduction of the pedicled tube graft for plastic reconstruction of the ear, recently reported 2 highly successful cases of its employment in conjunction with reinforcement by costal cartilage for the repair of partial avulsion of the auricle.

In the case which we are about to report, following the failure of pinch grafts to repair the defect resulting from scalping, pedicled tube grafts were



Fig 7 left The new tube taken from the left side This is a large pedicled graft and has now been attached at the base of the skull posteriorly near the occiput This tube is to form the large covering for the avulsed area

Fig 8 Lateral view looking from the right showing loss of the right ear The smaller pedicled graft is now in place at the right ear the large tube is attached posteriorly

The entire avulsed scalp was replaced in 1 piece in 21 cases, in all but 1 of which there was total failure, complete healing occurring in the single exception after 98 days In this extraordinary case, reported by Malherbe in 1898 the scalp was cleansed with sublimate solution (1 to 1000), and reattached with 40 sutures counter openings being made in the vertex of the skull and 8 drains placed in the scalp and in the skin of the forehead and neck According to an account by Lejars quoted by Davis the scalp died but was converted into a parchmentlike covering or dressing of skin adherent to the cranium under which healing occurred without complications

Cases of complete industrial scalping recorded in which patients were treated by the Reverdin method numbered 7 all with apparently successful results Patients treated by the combined Reverdin and Ollier Thiersch methods totaled 10 with 7 successes and 3 failures Cases in which treatment was reported as by the Thiersch (that is to say Ollier Thiersch) method alone aggregated 25 with eventual healing in every one The type of procedure and the ultimate result of treatment are not specifically stated in the histories of the other cases of skin grafting It is interesting to note that small ulcerations which proved more or less resistant to treatment appeared on practically all grafted areas

Gould is believed to have been the first to employ a pedunculated flap (in his case from the back of the patient's neck) in 1908, to hasten healing of an area previously treated unsuccessfully with several Thiersch graftings Other expedients essayed in an effort to promote repair of the defect in a girl of 16 included implantation of the lining of a dermoid cyst and application of skin excised from a large ventral hernia All 3 attempts failed to produce an immediate effect in this case However the entire wound was almost completely healed about 2 years after the accident

In a case recently contributed by Mitchell an entirely new method of restoration originally devised by him comprised a series of incisions clear down to the pericranium, 3 at the lateral and 2 on the anterior and posterior aspects the resulting flaps being about $\frac{3}{4}$ inch wide with sufficient attachment at each end to allow of an adequate blood supply each succeeding whole thickness flap being undercut and levered toward the center without regard to hemorrhage The upper lateral flaps were first sutured together with strong catgut and the next lateral flaps were then sutured to the first leaving a gap of half an inch and the third lateral flaps next sutured to the second, leaving another gap of half an inch Anterior and posterior flaps were undercut, levered

a small area on the left, which later granulated satisfactorily. The pedicled graft was placed in position on the right side of the head near the ear.

A third plastic operation was performed under avertin and gas anesthesia on December 19, 1935. A second pedunculated tube was made on the left side of the back. This was much larger and contained considerably more skin. The purpose of this flap was to cover the entire avulsed area of the scalp. This tube was permitted to grow and establish itself. Following this operation the patient lapsed into shock, and a blood transfusion and stimulation were required.

Two months later the condition of the tube graft on the left side appeared satisfactory and the general state of the patient was markedly improved. At this time the pedunculated tube graft from the left side of the back was attached to the left side of the scalped area in the occipital region. The graft held firmly without any evidence of supuration.

After 2 more months the graft was entirely detached from the back, the pedicle was turned, and it was then attached to the forehead, presenting a large area of full thickness skin attached anteriorly above the eye and posteriorly at the occiput. This tube graft was quite heavy and adhesive plaster was necessary to support it so that it might not detach itself from the newly grafted area. Later this wide tube was opened and spread over the entire scalped area and sutured in position. The patient's condition was not too good, and only brief procedures were permissible, so that the time required for the various steps of this grafting procedure was naturally longer than usual. Several plastic operations were necessary to smooth the flap over the scalp and give it the proper conformity and contour.

Later the tube which had been placed for the right ear was molded to produce an ear with some shape, as shown by measurements made on February 14, 1937.

Left ear	Right ear
6 cm long	6 cm long
2 5 cm wide	3 5 cm wide
6 5 cm in circumference	9 5 cm in circumference
Distance from sinciput— 15 cm	Distance from sinciput— 16 cm

The final plastic operative procedure was the transplantation of a large piece of cartilage from the seventh rib on the left side. This cartilage was placed in the tube graft which had been previously fitted at the side of the ear. The tube was opened and the cartilage inserted therein so as to give the ear its erect appearance.

The patient left the hospital following this final procedure. The last plastic operation was performed approximately 19 months after the original injury.

It is our opinion that another pedunculated tube taken from the axilla and transplanted on the right side of the forehead would make even a more satisfactory and presentable appearance. However, the patient who has been most co-operative, seems entirely satisfied. The scalp is well covered and protected and a transformation which has been secured gives this patient a cosmetic result that is most desirable. She certainly has no reason for any em-

barrassment and presents only slight deformity, which is negligible after the artificial hairdress is in place.

SUMMARY

1 Avulsion of the scalp is a rarity. However, every surgeon, general or plastic, should be familiar with the possibilities of grafting for the repair of such an injury, particularly in industrial surgery.

2 A review of the literature and our own practical experience prove that the Ollier-Thiersch and Reverdin grafts are not satisfactory in the reconstruction of large areas of avulsed scalp.

3 It is necessary to protect the cranium and pericranium adequately by a definite full thickness skin flap, in order to have a transformation or artificial hairdress approximate it satisfactorily.

4 Pedicled tube grafts obtained either from the axilla or back are the most desirable for the purpose of the full thickness skin flap which is to be utilized in replacing the scalp.

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Fig 13



Fig 14



Fig 15

fashioned from pedunculated flaps dissected from both sides of the back and transferred one to the scalped area the other to the site of the avulsed ear where the absent member was reconstructed with the aid of transplanted costal cartilage. The successive stages of the entire procedure are admirably illustrated in the accompanying photographs

CASE REPORT

CASE 1: Mrs I K, aged 25 years, a garment maker while at work on the afternoon of September 3, 1935 stooped to pick up an object which had fallen under her machine. In doing so her hair was caught in the flywheel of the machine and the entire scalp together with the right ear was torn off.

The patient was admitted to Providence Hospital in a state of profound shock. Examination revealed complete

Fig 13 The attachment of the small tube at the site of the external auditory canal. The ear is now beginning to assume some shape and conformity. The scalped area has been covered.

Fig 14 A profile or lateral view showing scalp completely covered and ear in position. The cartilage has been transplanted to give it conformity and to prevent sagging of the tube.

Fig 15 Shows patient following recovery with artificial hairdress or transformation in place. Note the absolute lack of disfigurement. There is no tightness to the scalp and no discomfort.

traumatic avulsion of the right side of the scalp down to the pericranium and of the right ear extending downward on the forehead and backward to the occipital region above the neck. There was also an adjacent area on the left side of the scalp completely torn off. The only remaining portion of the scalp was a small area in the left temporal and parietal regions.

Treatment for shock was immediately instituted. Large simple dressings were placed over the denuded areas, and antitetanic serum was given. The dressings were ordered continued daily until the patient became healthy and free from the possibility of infection.

It was not until 3 weeks later on September 24, 1935 that pinch grafts were applied to the scalped area under avertin and gas anesthesia. A pedunculated tube graft was also dissected from the back as the first stage of the plastic operation for reconstruction of the right ear.

On October 7, 1935 the patient's condition appeared quite satisfactory. The pedicled graft was growing nicely. Although some of the pinch grafts had taken the majority of them had sloughed away. It therefore appeared necessary that some other form of grafting be employed to cover the pericranium.

Accordingly on November 7, 1935 under avertin and gas anesthesia a plastic sliding graft was applied to the scalped area. This sliding graft was made by using the small area on the left side of the head which had not been avulsed and undermining and sliding it over to the center or middle portion of the head. This then left two areas of denuded skin, namely the avulsed area on the right and



Fig 1. a, left, Malunited Pott's fracture b, Good weight bearing alinement after supramalleolar osteotomy of tibia, note engagement of fragments of fibula necessary to maintenance of reduction following osteotomy

In all open reductions there should be as little detachment of the soft structures as possible, as the circulation to the bone is largely derived from this source, there will be arrest or delay in the delicate physiological process of repair if there is excessive stripping of the periosteum from the circumference of the bone

It is practically certain that a much better mechanical procedure can be carried out by wide exposure of bone, but often the purpose of



Fig 2 Fusion combined with osteotomy for malunited Pott's fracture.

the procedure is defeated by retarding the process of repair.

Delayed union in fractures is becoming much more frequent, and is a very definite contributing factor to malunion. The increase in number of fractures in which repair is retarded is due to three factors: (1) a relative increase in the number of fractures in recent years; (2) more severe injuries to the soft structures than ever before, and (3) repeated attempts to reduce a fracture, excessive skeletal traction, or destructive or excessively traumatic surgery which impairs the physiological process of repair. When union is delayed, there is



Fig 3 a, left, Old depressed fracture of internal condyle of tibia with varus deformity of knee b, right, Good correction following osteotomy and insertion of graft into osteotomy site to maintain position

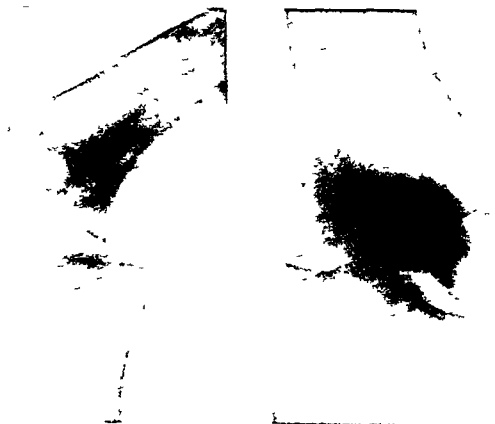


Fig 4. Lateral and anteroposterior roentgenograms of fracture of the posterior portion of the external condyle of the femur with valgus deformity of the knee

MALUNITED FRACTURES

WILLIS C CAMPBELL, M D, F A C S, Memphis, Tennessee

MALUNITED fractures are of such frequent occurrence as to be of prime importance, and yet there has been very meager consideration of the subject by the medical profession. This discussion is based upon an analysis of approximately 700 malunited fractures from the records of the staff of the clinic with which I am associated.

Fractures which were observed in malposition before union had occurred, i.e., delayed or non union, are not included, otherwise there would probably be 2,000 in which anatomical alignment of the fragments was abnormal. A malunited fracture or a fracture with vicious union is one in which there is clinical union in an abnormal relation, malposition or deformity.

Although motion may not be clinically demonstrated at the fracture site, consolidation is frequently not complete, the degree of union in a malunited fracture may vary from early callous, to complete solid osseous union. Function may be seriously impaired in various ways: there may be blocking of a neighboring joint by the projection of overlapping fragments, angulation and rotation of the fragments may interfere with proper balance or overriding of the fragments may induce material shortening.

The causes of malunion may be enumerated as follows: 1. failure to properly reduce the fresh fracture; 2. failure to maintain reduction until there is sufficient consolidation.

The first requires no explanation and is the more frequent, but a high percentage is due to the latter. Failure to maintain reduction is due to several causes which may be enumerated as follows: (a) insufficient immobilization during the process of repair; (b) inefficient routine observation; (c) insufficient protection after union is apparently solid; (d) disregard of the physiological principles involved in the healing of a fracture.

Fixation may be inadequate from insufficient dimension of the splints or plaster casts: for example, in fractures of both bones of the forearm a splint or cast that extends from the heads of the metacarpal bones to, but not above, the elbow is obviously insufficient. Frequently a cast is either

too loosely applied or becomes so after swelling has subsided, thus permitting displacement after reduction has been accomplished.

The failure to carry out efficient observation and after treatment is probably the cause of a large percentage of malunited fractures. When ever there has been a complete fracture with displacement of the fragments, roentgenograms should be routinely made to confirm proper position 1 week after reduction or before if symptoms suggest possible displacement. Before consolidation is complete the splint or cast should be removed and the member actually inspected and roentgenograms repeated, then, if the anatomical alignment is not correct, adjustment can easily be made. A roentgenogram should also be made after union is clinically solid, though this may not determine the degree of union present in adults. In fact, in adults union can rarely be determined by the roentgenogram alone until the lapse of several months. Malunion, especially angulation frequently occurs after union is clinically solid; this is particularly true of fractures of the shaft of the femur, middle and lower third of the leg and both bones of the forearm. Angulation can be prevented by maintaining position and alignment with appropriate apparatus until solid osseous union can be undoubtedly demonstrated both clinically and by roentgenograms.

The removal of a portion of a splint and the relatively early application of physiotherapy as a routine after treatment is the cause of many malunited fractures, whether this is done under the direct observation of the surgeon or by the surgeon himself. Regardless of how skillful the surgeon may be, internal displacement, especially in the region of a joint, can and does occur without apparent early external change and as is well known even the slightest change in position or angulation of a fracture near a joint may cause gross deformity and disability. In Pott's and Colles fractures such measures are frequently advocated.

There are measures to stimulate circulation and prevent excessive atrophy which are quite sufficient without disturbing fixation such as active use of the fingers and exercises to the shoulder and elbow in Colles fractures, and early weight bearing with absolute fixation in Pott's fractures.



Fig 1 a, left, Malunited Pott's fracture b, Good weight bearing alignment after supramalleolar osteotomy of tibia, note engagement of fragments of fibula necessary to maintenance of reduction following osteotomy.

In all open reductions there should be as little detachment of the soft structures as possible, as the circulation to the bone is largely derived from this source, there will be arrest or delay in the delicate physiological process of repair if there is excessive stripping of the periosteum from the circumference of the bone.

It is practically certain that a much better mechanical procedure can be carried out by wide exposure of bone, but often the purpose of



Fig 2. Fusion combined with osteotomy for malunited Pott's fracture.

the procedure is defeated by retarding the process of repair.

Delayed union in fractures is becoming much more frequent, and is a very definite contributing factor to malunion. The increase in number of fractures in which repair is retarded is due to three factors: (1) a relative increase in the number of fractures in recent years; (2) more severe injuries to the soft structures than ever before; and (3) repeated attempts to reduce a fracture, excessive skeletal traction, or destructive or excessively traumatic surgery which impairs the physiological process of repair. When union is delayed, there is



Fig 3 a, left, Old depressed fracture of internal condyle of tibia with varus deformity of knee b, right Good correction following osteotomy and insertion of graft into osteotomy site to maintain position



Fig. 4. Lateral and anteroposterior roentgenograms of fracture of the posterior portion of the external condyle of the femur with valgus deformity of the knee.



Fig. 5 Same patient Excellent reduction maintained by two wire nails valgus deformity corrected

obviously more probability of displacement or angulation during the process of osseous fusion

TREATMENT

The indications for treatment and the type of treatment selected depend upon the individual case. The degree of deformity, location of the fracture, age, temperament and general condition



Fig. 6 Same patient. Satisfactory alignment and position with solid union following osteotomy and reduction



Fig. 7 Malunited fracture of shaft of femur with marked overlapping of fragments

of the patient must be duly considered. Slight deformity, with excellent function and without pain and disability is not sufficient indication for operative measures regardless of the earnest desire of the patient. Any individual who is willing to undergo a major operation for the correction of a slight irregularity will usually not be satisfied with the cosmetic result, or will develop symptoms elsewhere of equal gravity. The age of the individual is of material importance. In children correction of gross deformity may often be accomplished by growth, consequently unless quite severe a course of watchful waiting is often rewarded by a perfect result. Otherwise operative correction can be carried out with success at a later time.

When malunion and deformity are associated with an epiphyseal injury which has caused abnormal growth successive correction by operative measures may be required before full growth is attained to prevent distortion of soft structures.

In older individuals above the age of 40 years if there is gross deformity with functional impairment and disability correction is indicated as in younger people but the type of operation may vary to some extent. For instance, an extensive and prolonged procedure to correct alignment and decrease shortening of a malunited fracture would be considered in a young individual. In an older patient, osteotomy alone with good align-

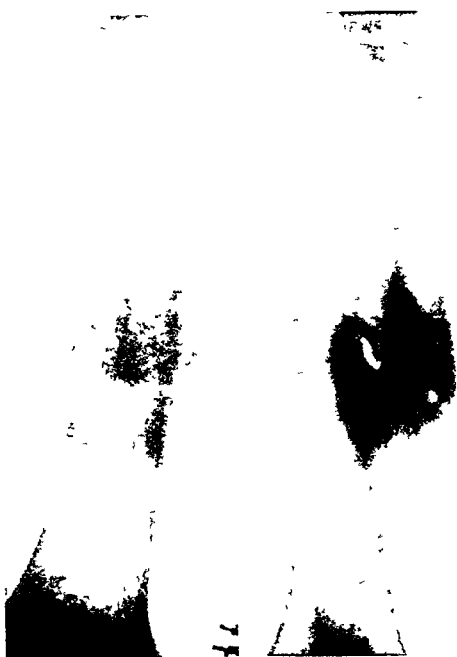


Fig 8 Malunited fracture of the shaft of the femur which is complicated by marked overlapping of the fragments

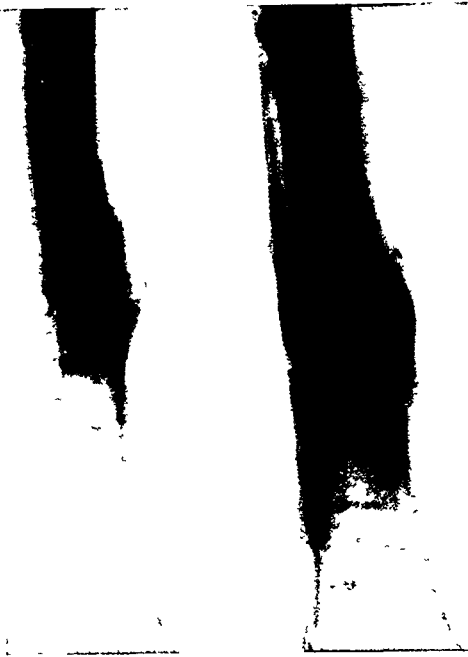


Fig 9 Same patient Excellent position following open reduction supplemented by onlay bone graft to insure union and maintenance of position

ment would probably suffice, with less risk and possibly a better functional result

The prophylactic treatment of malunion or the efficient treatment of fresh fractures will materially reduce the high percentage of malpositions, but until this is accomplished malunion will be of frequent occurrence

Correction of malunion is accomplished by operative measures, the nature of which may be enumerated as follows (1) manual correction; (2) osteotomy with (a) skeletal traction or alone, (b) open reduction, (c) internal fixation, (d) bone graft, (3) tenoplasties, fasciotomies, etc., (4) plastic reconstruction, (5) elongation with wedging by autogenous grafts to restore normal plane to joint surfaces, (6) fusion of adjacent joints, (7) operative measures for correction of associated deformities

The object of these procedures is to restore not only function and anatomical alignment but as nearly normal external contour as possible, a good cosmetic result is greatly appreciated, particularly in women

Of the 700 malunited fractures, operative measures were employed in 303 patients, of the remainder, either conservative measures were employed or the patient declined operation, and are

mentioned only to demonstrate the frequency of occurrence

The distribution of the operative cases may be tabulated as follows:

Part	Cases	Part	Cases	Part	Cases
Phalanx	1	Tarsus	7	Os calcis	14
Ankle	47	Tibial shaft	20	Tibial condyles	8
Femoral condyles	8	Femoral shaft	46	Femur upper third	5
Clavicle	5	Shaft of humerus	1	Lower third of humerus	51
Upper humerus	1	Both bones of forearm	6	Shaft of radius	15
Monteggia fracture	7	Colles'	48	Phalanx	2
Ulna, distal third	3	Metacarpals	5		
Carpals	1				

The procedures employed can best be demonstrated by discussing malunion in certain locations of most frequent occurrence. Obviously only a very general consideration of the subject can be made, as malunion in one location could form the basis for a lengthy discussion, as malunited Pott's or Colles' fracture.

While the majority of malunited fractures must be treated by open operative procedures, a small percentage, particularly of the shafts of the long



Fig 10 Lateral and anteroposterior roentgenograms of malunited supracondylar fracture of the lower part of the humerus



Fig 11 Same patient Satisfactory position after osteotomy position maintained by boiled homogeneous bone peg

bones, are amenable to manual procedures. In adults, if consolidation is not complete or in children angulation and rotation deformities particularly, may be corrected without surgery. Even with overlapping of the bones, union may be broken up manually followed by skeletal traction to decrease the amount of shortening with an ultimate good end result. Manual methods of correcting malunion must be attended with skill and care or fractures may be produced which complicate the pre existing deformity.

Malunited fractures about the ankle are of frequent occurrence. Operative measures were employed in 47 cases. In young individuals and in those in which there is no secondary traumatic or static arthritis, supramalleolar osteotomy of the tibia has been employed. In recent years in malunited Pott's fracture with a valgus deformity I have found that better alinement in the ankle could be secured if the osteotomy is through the tibia just above the internal malleolus and through the fibula at the point of fracture which is usually about 3 inches above the tip of the external malleolus. An oblique osteotomy is made so as to elongate the fibula then the fragments are notched and engaged or rarely internal fixation by the aid of a rustless steel wire may be employed. This reduction and engagement of the fragments of the fibula are of great importance in all fractures of the leg otherwise there is difficulty in maintaining perfect anatomical alinement. This factor particularly prevents rotation with a change in the static relations of the articulations of the ankle and foot.

In malunited fractures of the ankle in which there is inversion, elongation of the tibia is indi-

cated, and can be accomplished to a satisfactory degree by osteotomy and the removal of a graft from the anterior surface of the tibia through a separate incision. This graft is inserted into the line of the osteotomy so as to bring about the desired degree of correction. Usually from one fourth to one half inch increase in length can be accomplished which is all that is ever required. This not only restores the normal transverse plane of the lower extremity of the tibia and the ankle joint, but maintains this position until union is solid.

In malunion associated with subluxation open reduction may be employed in those observed early, but it requires such an extensive intra-articular dissection that the prognosis is doubtful. In those encountered after the lapse of over months, the feasibility of securing a movable joint without pain is questionable. In those in which the malunion has existed for a long period of time with secondary changes manifested in the joint, and in elderly individuals, fusion of the ankle with or without correction of alinement by osteotomy has been employed with very gratifying results and relief of disability regardless of ankylosis of the ankle joint. Undoubtedly fusion of the ankle should be more frequently employed in selected cases, for by this measure a serious disability may often be practically relieved.

In fractures involving the condyles of the tibia there may be depression with or without separation of the condyles. The knee may deviate into varus or valgus depending on whether the medial or lateral condyle is involved. There is usually a satisfactory or normal range of motion but with lateral instability due to apparent elongation of



Fig 12 Malunited comminuted fracture of lower end of humerus with solid bony ankylosis of elbow



Fig 13 Same patient after correction with arthroplasty

the ligaments, the relaxation being due entirely to the increased space between the articulations caused by depression of one of the condyles. Correction is usually accomplished by a complete transverse osteotomy through the entire tibia about 2 inches below the articular surface, after which a graft of about 0.75 to 0.5 inch in width and 2 inches in length is taken from the same or opposite tibia and inserted into the line of fracture so as to raise the depressed side. Unless there is such great separation of the condyles that the articulation is not tenable, no attempt should be made to enter the knee joint or to approximate the separated condyles. When approximation of separated malunited fractures of condyles is necessary, apposition can be maintained only after osteotomy by internal fixation, as with rustless wire nails or bolts as employed in fresh fractures. After the operation is completed, there will be no relaxation in the ligaments and the joint will be perfectly stable. The tibial plateau is restored to the normal plane and so maintained by the graft inserted at the point of osteotomy. Union is usually secured in 8 weeks, a brace should be employed to prevent lateral movement in the joint.

Malunited fractures of the condyles of the femur do not require osteotomy with elongation by bone graft as frequently as the condyles of the tibia. But restoration of the plane of the femoral articular surface to as near normal as possible is required. This is usually accomplished by an osteotomy through the line of fracture or as near as possible, after which the displaced condyle is

brought down to the normal position and is transfixed by two long rustless steel nails. Great care must be exercised not to detach any more than necessary, the soft structures from the fragment to be repaired; otherwise more or less sequestration may occur, causing an irregular or incongruous joint.

In open operative measures for malunited fractures of the shaft of the femur, plastic procedures must be devised so as to permit as much elongation as possible after osteotomy. Those of short duration with an overlap of fragments or with angulation may be dissected loose and made transverse, after which reduction may be accomplished by angulation and by bringing the lower fragments in line with the upper until complete locking may be accomplished. Rarely, approximation with locking of fragments may be accomplished only by extending the hip and bringing the upper fragment down to the lower. Usually after reduction the tension is so great that firm fixation is secured; however a Kirschner wire is always inserted through the femur just above the level of the condyles and incorporated into the cast so that skeletal traction may be employed later if there should be a disengagement of the fragments with a recurrence of malposition. In those in which fixation is secured by bringing the lower fragment to approximate the upper, the extremity is immobilized in flexion of the hip and knee to about 150 degrees and abduction of the hip to 120 degrees. When approximation can be made only by bringing the upper fragment down to the lower, the limb is

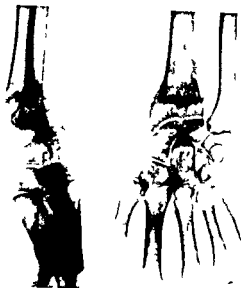


Fig 14 Malunited Colles fracture note dorsal angulation of distal end of radius and radial shortening



Fig 15 Same patient Radial shortening and angulation corrected following osteotomy and insertion of two-dimensional wedge obtained from prominence of ulna

placed in a straight line with the slight abduction and the hip and knee are extended. Union is usually secured without decrease in length of more than one half inch or less.

In those fractures of long duration in which there is only about 1 inch shortening, a simple transverse osteotomy as in the correction of a varus deformity of the knees is usually sufficient great care being used to correct the tendency of the lower fragment to rotate inward. If there is shortening of over 2 inches, osteotomy by a more or less Z plastic or oblique severance may permit an increase in length. If only an osteotomy or chisel is employed irregular fractures in undesirable directions may occur consequently in order

to sever the bone accurately by any well planned osteotomy drill holes are made to outline the line of osteotomy, and then osteotomy is made by a chain saw or small chisel. If possible a motor saw should be used but this may require too much separation of soft structures from the bone.

After the oblique osteotomy if there is sufficient contracture to prevent an immediate increase in length, skeletal traction may be employed by means of the Kirschner wire or by the Roger Anderson appliance until as much increase in length as possible is secured after which external fixation by a cast is employed until union is solid.

Frequently in malunited fractures of the femur some means of internal fixation must be used to maintain the position of the fragments. This is most efficiently accomplished by means of the onlay bone graft, as it not only fixes the fragments but promotes osteogenesis so that union occurs in a much shorter space of time.

Malunited fractures of the clavicle, though of frequent occurrence rarely require correction. This has been necessary in only three instances. The procedure in the clavicle employs essentially the same principles as in the femur, but internal fixation by rustless steel wire is usually necessary. A long period of recumbency may be required if anterior and upward bowing is to be completely prevented unless a massive bone graft or some type of metal plate is used.



Fig 16 Same patient Perfect cosmetic result following bone plastic operation for malunited Colles fracture

Operative procedures for malunion of the upper extremity of the humerus are rarely required, as there is considerable compensatory motion in the shoulder, besides the shoulder itself is a rather loose joint and accommodates readily for considerable angulation and deformity. However, malunion may occur if dependence is placed upon an anterior posterior roentgenogram, a lateral view occasionally reveals gross displacement and angulation.

Malunion of the shaft of the humerus rarely if ever requires surgical correction, as good function, through compensatory motion of the shoulder and forearm, is compatible with considerable bowing and distortion.

Fractures of the lower end of the humerus involving the elbow joint are of frequent occurrence and often require operative correction. In this series there were 51 cases in which surgical treatment was required. In supracondylar and condylar fractures, a complete osteotomy in the line of fracture is required after which the fragments are restored to their normal position and so maintained with wire nails. The contour of the joint must be restored to as nearly normal as possible. At this location, aid is sought much earlier than in most locations, and as a majority in this location are in children, malunion is observed earlier. The results in children are excellent and much better than in adults. In adults after excessive comminution and incongruity of articular surfaces with excessive callus, an arthroplasty or reconstruction often gives by far the best results and should be more frequently employed.

In the forearm there were 31 fractures which required operative reduction. In malunited comminuted fractures of the head of the radius, excision below the bicipital tuberosity is indicated, but with varying results. In some instances function is restored to normal while in others there remains a more or less painful member with limitation of motion. This seems to depend on the fibrous and osseous reaction of the individual, regardless of care taken to remove completely periosteum and all spicules of bone. In fractures just below the head of the radius the slightest angulation may cause marked limitation in rotation of the forearm, consequently malunion in this location must be corrected by osteotomy and internal fixation. In this location even in children 10 years or older there may be a permanent limitation of motion.

Fracture of the upper third of the shaft of the ulna with dislocation of the head of the radius is a notorious combination—the so-called Monteggia fracture. Perfect reduction is difficult, but if not

secured, material impairment in function of the elbow may be expected. Malunion in this fracture occurs in a high percentage, and can be corrected by osteotomy of the upper third of the shaft of the ulna, after which the head of the radius is exposed and reduced, and so maintained by a transplanted strip of fascia lata passing about the neck of the radius and through the ulna. The osteotomy in the ulna is held in position by rustless steel wire, plate or bone graft and a plaster cast immobilizes the forearm and elbow.

Malunited fractures of the shaft of the ulna, except in combination with dislocation of the head of the radius, are infrequent. Malunion of the radius in the upper or lower third is much more frequent. In the upper third, forward bowing due to the pull of the biceps is the usual cause and must be prevented after osteotomy. In the lower third, there is also anterior bowing which must be prevented. In either location some type of efficient internal fixation may be advisable. Malunion of both bones of the forearm rarely requires operative measures, but, when necessary, simple osteotomies are usually sufficient with the greatest care to prevent backward bowing, especially in the ulna.

Malunion in fractures of the lower extremity of the forearm is of frequent occurrence, especially the malunited Colles' fractures. The patients present themselves to secure relief not only from the unsightly deformity but from persistent pain and disability. There were 48 of this type.

Three procedures may be employed to correct malunion of a Colles' fracture: (1) resection of a segment of the distal end of the ulna; (2) osteotomy of the radius through the fracture site; (3) bone plastic procedure. Resection of the ulna is a compensatory procedure with no attempt to correct the existing deformity. Osteotomy alone allows correction of the angulation present but is insufficient, in that radial shortening is not corrected and the distal end of the ulna continues to be prominent, resulting in a poor cosmetic result. The bone plastic procedure consists of a transverse osteotomy about 1 inch above the lower extremity of the radius, after which by a second incision the projecting portion of the lower extremity of the ulna is resected and transplanted between the fragments of the radius, thus elongating the radius to normal length and restoring the contour of the wrist joint to normal. This procedure was described before the orthopedic section of the American Medical Association at the Atlantic City meeting, and the description was published in the October 2, 1937, issue of the *Journal of the American Medical Association* to which

reference can be made for minute description of the technique

No attempt has been made to describe minutely the technique of correction of malunion of all bones, the principles described, however, may be employed in other locations. Physical therapy must be instituted but not until union is sufficiently solid to withstand the stress. No tried and fast rules can be given as each fracture is an individual problem unto itself, requiring experience and judgment.

All malunited fractures of the ankle require protection by apparatus from 1 to 7 months after removal of splints or casts. An arch support and brace with varus or valgus T straps are usually required.

In malunited fractures involving the articular surface of the knee physical therapy is instituted at the end of 4 weeks, after 8 weeks walking is permitted with the aid of a walking caliper. Thomas knee brace, which transfers the weight of the body to the ischial tuberosity and the perineum. Full unprotected weight is not permitted until union is absolutely solid and the osseous structure approaches normal, as demonstrated by the roentgenogram and by clinical examination. This may take as long as 4 to 6 months, but if weight is borne too early there will be either recurrence of the displacement or compression of the articular surface.

In all malunited fractures of the femur protection by means of a leather corset brace with Thomas ring support is required for several months after union is clinically solid. As soon as union is clinically solid physical therapy is employed to the knee but with caution.

In the upper extremity protective apparatus to insure maintenance of position until osseous union is complete is routinely employed but not as extensive or prolonged as in the lower extremity where too early weight bearing is such a preponderant cause of recurrence of malunion.

The end results in the treatment of malunited fractures cannot be estimated in percentages due to the varying complications present, but the re-

sults on the whole are excellent, with material decrease in disability, and in a small percentage complete restoration to normal.

Secondary compensating or associated changes in adjacent joints as distortions of the foot—equinus varus, valgus—and flexion of the knee are quite common and require separate surgical measures for correction, as tenotomies, fasciotomies, osteotomies, which are not pertinent to the subject.

There are several factors which should be emphasized.

1 The correction of a malunited fracture is an individual surgical equation which must be devised to meet the mechanical requirements of each case.

2 Protection by apparatus of malunited fractures after open reduction is usually required as after all open operations upon fractures, union is potentially delayed and there is danger of malposition.

3 Operative measures in malunited fractures that involve an articulation should avoid invasion of the joint when possible.

4 In malunited fractures about the ankle and the leg, the fracture of the tibia should not be disregarded. There should be accurate reduction of the tibia which is a very important factor in maintaining alignment, and preventing displacement of the foot and ankle. The same principle is of equal importance in fresh fractures to prevent malunion.

5 The employment of autogenous grafts for the purpose of elongation, the correction of deviation, and to restore the normal articular plane by inserting between fragments after transverse osteotomy is a valuable procedure that is successful in practically every instance if it is efficiently applied.

6 The large number of fractures encountered in which malposition is discovered before union has occurred in delayed union in non union and in actual malunion or vicious union is sufficient evidence that fractures are not efficiently treated and even more strenuous efforts should be made to rectify this condition.

PHYSICAL THERAPY IN RELATION TO INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

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THE tremendous growth of human enterprise since the beginning of this century has been followed by new dangers to the health of man. It is a great responsibility that has been added to organized medicine, and it is our duty to use all our means to prevent industrial disability, as well as to treat the victims of our even more complicated modern communities. An important therapeutic measure in industrial medicine and traumatic surgery is physical therapy.

Physical means were the basis for treatment on the island of Cos in 400 B.C., where massage, exercises, water, and sun were used to restore the sick to health. In our days, during the World War all useful procedures in this line were concentrated in the base hospitals in order to get the disabled soldiers back to the front as soon as possible. Physical therapy received its "baptism under fire" so to speak. Many doctors were introduced to therapeutics of which they had little knowledge, but which they accepted indiscriminately. When the war was over the medical profession was confronted with modern industry enormously increased and producing problems similar to the war.

One of these problems was the care of the victims of modern industry and modern transportation. Physical therapy was employed extensively both by institutions and by private practitioners. Manufacturers flooded the market with all kinds of appliances which were forced on the medical profession by high powered salesmen. In 1927 the American Medical Association created a Council on Physical Therapy. This council is to physical therapy what the Council on Pharmacy is to the drug therapeutics. The Council on Physical Therapy is curbing commercialism and unwarranted claims for apparatus. It advocates basic training in undergraduate and graduate medical schools, as well as in the county and state medical societies.

The Council on Physical Therapy of the American Medical Association has defined physical

therapy as the application of heat and cold, the actinic rays, water, electricity, massage and therapeutic exercises. Physical therapy as you know it in traumatic surgery is only a part of physical therapy as a whole. Such treatments as underwater exercises for poliomyelitis, ultraviolet radiation in rickets, heliotherapy in extrapulmonary tuberculosis, hyperpyrexia in gonorrheal arthritis, corrective exercises and postural training, and hydrotherapy in the management of arthritis, are fairly well established.

What is the relation of physical therapy to industrial medicine and traumatic surgery, who should use it, and how much is rational therapeutics? I believe that there is little indication for specialists in physical therapy except in the larger hospitals and teaching institutions. Physical therapy should be a part of the surgeon's armamentarium. I agree fully with Dr. Mock who has said that 65 per cent of all industrial cases need physical therapy. Fifty per cent of these can be treated with application of heat, massage, and therapeutic exercises, the next 25 per cent require some apparatus, such as whirlpool baths, diathermy, and ultraviolet radiation which can all be done by the practitioner. Only the last 25 per cent require physical therapy methods that involve more experience and specialized knowledge, such as electrodiagnosis, ionization, etc.

The efficiency of heat and massage and therapeutic exercises in the management of the traumatic patient is such that it will answer our purpose in most cases. Much of the physiological action that we depend upon is through the circulation. Some years ago I worked out the following experiment: I injected 1/10 cubic centimeter normal saline subcutaneously, and found, if left alone, that it would be absorbed in 51 to 61 minutes. If massage was applied it would disappear in 6 to 9 minutes.

Table I shows the great value of massage; that it is far more efficient than the other modalities.

A few years ago I collected 100 consecutive traumatic cases in which the patient paid for his own treatments, and compared them with 100 consecutive compensation cases of similar diagnoses. I found that the latter cases received 20 per cent more treatments before discharge. There

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TABLE I—CIRCULATORY ACTION OF PHYSICAL MODALITIES

1/10 c cm normal saline injected subcutaneously is absorbed—	Minutes
Normally in	56 to 61
By massage in	6 to 9
By electric vibrator in	9 to 11
By ultraviolet radiation in	30 to 33
By static wave current in	30 to 33
By whirlpool in	30 to 33
By thermo-lamp—375 watts—60 cm in	35 to 38
By infrared—600 watts—60 cm in	40 to 42
By diathermy—cuffs—1000 m amp in	42 to 44
By galvanic current in	44 to 46
By faradic current in	46 to 47
By sinusoidal current in	47 to 49
By passive exercises—Zander in	50 to 55

were undoubtedly abuses of physical therapy. This was especially true between 1920 and 1930. Large industrial clinics were organized for profit rather than for cure. I know of one such clinic where one technician treated an average of 60 patients a day. Such treatments were of course inadequate to say the least. A reaction to such treatment in addition to the economic depression brought a more critical attitude toward the treatment of the industrial patient and especially the generous use of physical therapy in the convalescent stage. Physical therapy is on trial and I am willing to give my testimony. I am in charge of physical therapy in two large New York hospitals on a salary and therefore without financial interest as to whether a patient has one treatment or a hundred. I am concerned only with the complete restoration of the patient as early as possible. My judgment is therefore not exposed to temptations of prolonging treatments for financial gains.

In this paper I shall confine myself to the methods of physical therapy commonly used in traumatic surgery. My intentions are not to go into detail but I shall attempt to direct in a general way your appreciation of physical therapy.

Fractures. The modern treatment of fractures recognizes the break in continuity of the bone as well as the damage to the soft tissue. We must realize that we are dealing with a whole individual who has an extremity which has a fracture. Murray states that physical therapy in fractures minimizes chances of delayed union, prevents the organization of scar tissue in muscles, joint capsules and tendons, decreases the functional limitation that otherwise has to be dealt with after the bone has healed. If we review the physiological healing of a fracture based on experimental work on bone repair, we may divide this repair into 5 stages.

First stage. The immediate result of a fracture

is a hemorrhage, which is central, subperiosteal and muscular. This hemorrhage produces the clinical symptoms of pain, swelling and muscular spasm. These symptoms indicate nature's attempt at immobilization. After best possible reduction has been obtained, our efforts should be to maintain this.

Second stage. A few hours after the fracture, a productive inflammatory process begins, which through granulation tissue formed and the evaporation of fibrin and serum, changes into a hematoma. The clinical symptoms of pain, swelling and muscular spasm persist, they tell us to keep our hands off and to maintain immobilization.

Third stage. Forty eight to 72 hours after the reduction the hematoma surrounding the fragments is further organized by connective tissue osteoblasts appear, and some bone matrix is formed from the intracellular substance. Pain and muscle spasm have disappeared and swelling decreased.

Fourth stage. On the fourth or fifth day we have a soft callus consisting of osteoid tissue. The calcium salts (calcium phosphates and calcium carbonates) are deposited in the connective tissue stroma.

Fifth stage. After the first week the connective tissue is well organized, osteoid tissue appears and there is a general transition of the cells from connective tissue to osteoid tissue to bone. At this stage the patient often complains of stiffness in adjacent joints, the soft parts about the fracture are described as lifeless. Now we are dealing with a convalescent fracture in which the bony repair has gone into a soft callus, and there are no muscular spasm, swelling or pain which contraindicate restoration of function.

The physical therapy treatment should start in the third stage, i.e., the second or third day of healing whenever possible. The functional restoration should go hand in hand with the healing of the fracture. If this is followed there is no period of after treatment and when the fracture is healed the damaged soft tissue and the adjacent joints are normal in function. Muscular strength and coordination of muscles are best obtained by occupational therapy.

Where complications follow such as traumatic arthritis, contractures or bone atrophy, paraffin applications may be used or diathermy, short wave, or electrical stimulation of muscles.

I believe that this treatment should be directed and supervised by the surgeon responsible for the fracture. His duty is not only to bring about the union of the fracture but to return the patient to his pre accident functional activity.

The importance of active exercises cannot be emphasized too greatly. Let the patient take some of the responsibility, exercises with a purpose such as occupational therapy are superior to passive movements with expensive apparatus.

The infected hand. The infected hand is a very common and a very serious problem for the traumatic surgeon. Kanavel's work on this subject as to the pathology and surgery is a classic. However, after the hand has been properly incised, the restoration of function is often hampered by immobilizing dressings. The fingers are not moved for several weeks, and adhesions are laid down between the tendon and its sheath, the joints undergo arthritic changes, and the soft tissue atrophies, resulting in a very useless hand with a high percentage of disability. Physical therapy can be of real aid to the traumatic surgeon in these cases, in the form of whirlpool baths and active exercises. On the third day after the incisions have been made there is probably very little chance of any bleeding, and this is the time for submersion in the whirlpool for 15 to 30 minutes. The whirlpool bath is a basin into which water of 110 degrees is forced by 50 pounds pressure, forming a whirl. It has an osmotic effect on the soft tissue, a mechanical cleansing effect, and also produces slight molecular massage on the hand. The patient is encouraged to move wrist and fingers, which makes it similar to Willem's treatment which was popular during the war. The basins are cleansed with lysol after each treatment, and I have never seen any re-infection caused by this treatment. This procedure should be followed twice a day, and every 2 days a suberythema dose of ultraviolet to sterilize the skin and external wounds should be applied.

For localized infections anywhere on the body I have been much impressed by Cooley's compress. It consists of a rubber covered heating coil, which is controlled by a rheostat. It maintains a temperature of 140 to 160 degrees Fahrenheit. Between the coil and the skin we have a flannel compress, which is saturated with fluid. In the flannel compress we have a sleeve which runs to the center of the coil and holds a thermometer. Various kinds of fluids are used to keep the flannel compress moist. Boric acid is useful for eye infections, normal saline for preparation for a skin graft, half strength Dakin for osteomyelitis, and magnesium sulphate 5 to 10 per cent for localizing infections. Of course the patient is hospitalized, and compress is kept on both day and night. As in the treatment of fractures, the physical therapy should go hand in hand with the surgical treatment. If the functional treatment

is started only when the wounds are healed, it will often result in a "frozen hand." The treatment recommended for this condition is paraffin dips, strong electrical stimulation to the muscles, and active and passive exercises. The paraffin dipping is a simple procedure which can also be carried on by the patient at home. We use laboratory paraffin which melts at 150 degrees; then it is cooled to 130 degrees and the hand is immersed 12 times. The paraffin glove thus formed is kept on 15 minutes, and the hand is ready for massage.

Low back pain. When we changed from quadruped to a biped position, the greatest change took place between the trunk and the pelvis. This change concerned both the anatomy and the physiology. To a weakened anatomical structure was added an increased activity. The angle between the trunk and the lower extremities was increased 90 per cent. This was accomplished by stretching certain muscles and shortening others. The weight bearing alone was difficult in the new biped position, and now when we add stress and strain to this area of the body as we do so much in our industrial work, there is no wonder that low back pain is a very common occurrence that we are called upon to treat. Most injuries to the lower back involve the soft tissues only, and are not demonstrable by x-rays. I shall limit my discussion to low back injuries and exclude fractures, subluxations, arthritis, neoplasms, referred pain, etc.

What has physical therapy to offer in these back pains? If you will agree with me that a vast number of low back pains fall into a group in which no definite etiology can be established, except that of faulty body mechanics, I shall endeavor to show you how an intelligent analysis of body mechanics may lead to relief and cure in these cases. However, you have to use some discrimination in the application. In discussing this subject with a doctor who had treated many back cases among the miners in Pennsylvania, he told me how he had journeyed to Boston to learn something of exercises for low back pain. When he returned home and tried to show the coal miners a set routine of exercises, he failed completely. He decided that what was good for the Cabots and Lodges was not good for a coal miner. The correction of body mechanics has to be individual and based on careful analysis. The skeleton is maintained in correct position by the muscles. However, it depends less on muscular strength than on balance of strength between opposing muscles. If you will visualize the pelvis as a double lever with the fulcrum in the hip

joint, you will find two muscle groups opposing each other posteriorly. They are the erector spinae quadratus lumborum, pulling upward and the hamstrings, piriformis, and gluteus maximus pulling downward. Anteriorly we have the anterior abdominals, especially the rectus abdominis pulling upward, and these are opposed by the hip flexors, the rectus femoris, iliopsoas, tensor fasciae latae and sartorius which pull downward. Mr. Philip Wiles of London has shown that the action currents of these muscles vary considerably, even in the same muscle depending upon the amount of work demanded. It is easy to understand how any overwork of any of these opposing muscle groups will unbalance the leverage. The most common occurrence is probably a weakening of the abdominal muscles which throws an increased strain on the opposing back muscles. These will soon be overtaxed go into spasm and begin to ache. The whole muscle balance which keeps the pelvis in correct position is upset and the stage is set for low backache which becomes chronic unless the mechanics are carefully analyzed and corrected.

The very common sciatic syndrome which often accompanies low back pain has been described by Dr. Freiberg as being due to pressure of the piriformis muscle over the sciatic nerve.

After we have established a weakness of the abdominal muscles, shortening of the hamstrings or a muscle tear of the low back muscles as cause for unbalanced support of the pelvis our treatment consists in (1) rest for the overworked muscle (2) support for the weakened muscles followed by strengthening exercises (3) stretching of the contracted muscles by the use of heat massage and manipulation to restore flexibility (4) correction of other faulty mechanics, for example the feet which may be the primary cause for the unbalance of muscle power about the pelvis.

This approach that I have attempted to outline is useful as a preventative measure. It is the only treatment in many cases and is supplementary to the treatment of nearly all low back pains.

The future development of physical therapy lies in the hands of the traumatic surgeon and the orthopedic surgeon. Most of our traumatic patients require simple physical therapy such as heat, massage, and therapeutic exercises applied with intelligence rather than with expensive apparatus. The surgeon responsible for the case should see the patient through to the final stage of complete functional restoration. Instead of dividing the treatment into a surgical treatment

and an after treatment, they should go hand in hand.

This can be done only if the surgeon employs properly trained technicians. My criticism of the traumatic surgeon is that he does not employ the best assistants. He often uses a nurse without physical therapy training or a masseuse with inadequate training. These are often picked because of their personality rather than their professional education.

The Council on Medical Education has set down certain requirements for physical therapy technicians that will lead to a national registration, certified by the American Congress of Physical Therapy.

It is evident that in our large hospitals and big industrial centers it is advantageous both economically and professionally to have more or less extensive departments of physical therapy with a specialist at the head. The type of hospital will determine the development of this department.

CONCLUSION

1. About 75 per cent of the traumatic patients require physical therapy. Of this number 50 per cent require simple physical therapy, and 25 per cent may require some apparatus but both these groups can be handled by the surgeon and his assistant. Only in the last 25 per cent may special consultation be advisable.

2. The surgeon should be responsible for the whole treatment both the surgical and functional treatment, which should be simultaneous.

3. This can be done if the surgeon will employ properly trained technicians as assistants.

4. Departments of physical therapy in our hospitals often require a specialist in physical therapy. This department should be used as a reference department similar to x-ray and laboratory departments.

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SYMPOSIUM: TREATMENT OF FRACTURES

ORGANIZATION OF REGIONAL FRACTURE GROUPS

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MORE and more am I convinced that the outstanding contribution to the treatment of fractures by American surgery in this twentieth century is the intelligent care of the injured person from the time of the accident until the resumption of pre-accident activities.

But you may say this includes every phase of the treatment of a fracture. I reply, it is intended to.

American common sense in surgery is an asset of no mean proportion. In general, in America, sound surgical judgment is more prevalent than poor surgical judgment, *but* the ignorance of professional men as to the treatment of a fracture is widespread.

Probably the incompetents and the morally obtuse of our profession can never be completely eradicated, any more than general society can be purged of those seeking something for nothing.

All of us are familiar with cases similar to the following:

CASE 1 A young adult of 24 years falls from a telephone pole while at work as a lineman. He breaks the left femoral shaft. He is taken to a nearby hospital. He is cared for by the attending surgeon. After 3 weeks, it is found that the abrasions below the knee are infected; that the thigh is curved backward and outward, and that there is shortening and no evidence of union.

CASE 2 A fracture of the leg below the knee. A plaster-of-Paris splint is applied to the whole extremity by the doctor. The nurse calls the doctor the same night, telling him the patient is in pain and that the toes on the injured side are blue. "A dose of medicine, I will see him in the morning." In the morning, the toes are black. The doctor removes the plaster splint, and an amputation at the middle of the thigh is done.

These are not isolated instances. We all know similar tragic experiences.

Such recurring instances of poor handling were the reasons for the formation of a fracture committee 16 years ago. With the increase in number and the growing complexity and seriousness of fractures, the same reasons for such a committee exist today and are more imperative than ever.

Presented in the Fracture Symposium, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937.

The surgical profession is awake to the need for improved methods of treating the injured.

There exists today a well organized movement within the surgical profession to further graduate teaching in the care of a fracture.

The 1,172 members of the fracture committee form a wide awake, active teaching group, eager to learn and ready to impart their knowledge on this important subject to the medical profession. Therefore, opportunities for graduate instruction in fractures exist in every state of these United States, and in every province in Canada.

I will present to you, today, certain of the ways in which the Regional Fracture Groups carry on in this nation wide propaganda. I will not in this brief statement tell you how each of the committees is functioning; but I have assembled a few methods which are characteristic of all the committees.

There are 66 regional committees, with a membership of 1,172. This is the largest postgraduate group attempting improvement in any surgical subject. A galaxy of teachers form this activity. Something good must result. Good has already resulted.

In general, the whole surgical profession is more alive and responsive to fractures than ever before. Individual fractures are being better treated.

The complications attending fractures are: (a) injuries to the cranial contents; (b) injuries to the spine and spinal cord; (c) injuries to the chest and its viscera; (d) injuries to the abdominal organs, with or without fracture of the pelvis; (e) nerve lesions of the extremities; (f) blood vessel damage. All these complications are being more surely recognized, and appropriate treatment is being instituted at an early date.

The disappearance of the old-time apathy of the medical profession toward fractures is not a mere coincidence. It is due in large measure to the active co-operation of the surgical profession through these regional committees.

I would not stress in this connection the rapidity of improvement in treatment, but rather the slowly moving medical mind in its apprehension of all that such co-operative action means:

better surgical results. And after all, this is our ideal better results in the treatment of fracture—making the fracture less disabling now and forever.

Every regional group in each state makes contacts with all agencies or organizations possible (1) doctors, (2) hospitals, (3) nursing associations, (4) social service organizations, (5) hospital associations, (6) medical associations and societies, (7) clubs, (8) the police, (9) fire departments, (10) safety organizations, (11) boards of health, (12) school committees, (13) trucking concerns, (14) Boy Scouts, (15) Girl Scouts, (16) American Red Cross local chapters, (17) industrial accident boards, (18) registrars of motor vehicles, (19) insurance companies, (20) the legal profession.

In what follows, I cite at random from the reported activities of the regional fracture committees in certain states. All state committees are busy some more so than others. It is important to have an active man in charge of a state committee who is informed, energetic, wide awake, and interested.

In Georgia Ambulances are all owned and manned by undertakers as is so commonly the case throughout the United States. The state association of undertakers was addressed and brought into line with the idea of the proper equipment of ambulances. The state superintendent of schools, and the superintendent of the public schools of Atlanta, both have been approached with reference to teaching first aid in fractures throughout the public schools of the state.

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The City Council of the City of Crookston Do Ordain
Section 1. No person, firm or corporation shall operate or cause to be operated any ambulance public or private or any other vehicle commonly used for the transportation or conveyance of the sick or injured without having such vehicle equipped with a set of simple first aid and splint appliances approved by the Board of Health and having in attendance at all times such vehicle is in use a person who has obtained a certificate of fitness as an ambulance attendant from the Board of Health.

Section 2. Any person desiring a certificate as an ambulance attendant shall make application in writing therefor to the Board of Health. Before the issuance of any such certificate the applicant therefor must present evidence of his qualifications to fill such position and must demonstrate to the satisfaction of the Board of Health his ability to render emergency first aid and to apply properly approved splints to arm and leg fractures.

Section 3. Any person violating the provisions of this ordinance shall upon conviction thereof be punished by a fine of not to exceed One Hundred and no/100ths (\$100.00) Dollars or by imprisonment for not more than ninety (90) days.

Section 4. This ordinance shall be in force and effect from and after its passage approval publication and record.

Upon the call of ayes and nays upon the passage of the ordinance the vote stood as follows:

Aldermen voting in the affirmative Widman Emmenich, Eickhof Spence Burkley Lanster Hag a Hamerlik.

Aldermen voting in the negative None.

Upon this vote the ordinance was declared passed by the President of the Council.

Passed this 13th day of April 1937.

J. Flynn President of the Council.

Approved the 16th day of April 1937.

W. J. Kirkwood Mayor

Attest

Bergetta M. Loken City Clerk

This ordinance was published in the May, 1937, issue of *Minnesota Medicine*, page 304.

Our committee feels that in obtaining the passage of such an ordinance in the various communities permanence of the movement is established to a certain extent and also that considerable public education results. We have used the moving picture films to supplement the arguments for the ordinance in education of the city officials and also of the profession.

As to *diagnosis*, rules are posted under glass and framed in the x-ray laboratories of all hospitals for the guidance of x-ray technicians

Co-operation is maintained with the Boy Scout, Girl Scout, Red Cross, and Highway Patrol organizations to improve first aid and transport of fractures

In Vermont. At the Medical School of the University of Vermont, medical students are trained in the use of traction in the transport of fractures. A survey of the hospitals of the state has been made in so far as fractures are concerned. Motor vehicle police, now furnished with automobiles, are manned by capable young men. The State Commissioner of Motor Vehicles is equipping the cars with splints. Committee on Clinical Meetings is active in all sections of the state. The prevalence of mal-practice suits has stimulated interest in the state fracture committee.

In North Dakota The Regional Fracture Committee of North Dakota has become the Fracture Committee of the State Medical Society.

In Montana The Regional Committee is in touch with men throughout the state able and willing and ready to present papers on fractures.

In Indiana. The state is thoroughly organized with 14 operating subcommittees. A very intensive work is being done.

In Connecticut. The State Department of Education probably will sponsor this winter a state convention for all interested in first aid. The State Department of Motor Vehicles, through its commissioner, has issued a circular of information regarding fractures. It has been planned with the telephone company so that a call from any section of the state, "Send an ambulance," will result in the call being relayed to the nearest police barracks.

The present subcommittees are: membership, liaison, ambulance equipment, hospital care and equipment, education and publicity, clinical meetings, ways and means. No splints were available

so the committee had them made at low cost. National Red Cross contact is maintained.

State Printing Press is utilized so costs to committee are nothing except for paper. Committee dues are two dollars. State has a highway safety department. A Commission of State Department of Education takes care of first aid instruction.

The Aetna Life Insurance Company has sponsored an educational film, "Emergency Splinting." The state medical journal in each issue carries an article of progress in fractures. The Safety Promotion Director under Motor Vehicle Commissioner is broadcasting and sending information to newspapers interested.

In New York. Many subcommittees exist. The subcommittee on follow up is working on a standard method so as to evaluate the efficiency of different methods of treatment. Transport of spinal injuries was discussed and studied. Earlier this year there was a "Fracture Day" at the New York Academy of Medicine, with papers in the morning, luncheon and papers in the afternoon, valuable for all doctors in the neighborhood.

These are some of the ways that the state regional committees are working throughout the country, attempting to help the profession to take better care of the individual with a fracture. The organization of the state regional committees is a major development in the move to improve the treatment of fractures, and these active groups, sponsored by the American College of Surgeons, form the largest, finest, and best organized graduate teaching body in America. From the graduate educational point of view, no subject in medicine or surgery is so well covered as is the treatment of fractures.

Gentlemen, in these matters we are all concerned and interested. Whether we are members of committees or not, all of us are responsible for elevating the practice of surgery in our home communities, for bringing the art of surgery nearer and nearer to its scientific bases.

Each one of us can do something. Co-operate whenever possible with your state committee. Hold fast to the truth that the treatment of fractures and their complications demands very special training and aptitude. See to it that some one in your district is so trained: thereby the art of surgery will be furthered, and the injured man will be treated in the best manner possible.

Thus successful progress will creep from point to point, testing each step.

better surgical results. And, after all, this is our ideal better results in the treatment of fracture—making the fracture less disabling now and forever.

Every regional group in each state makes contacts with all agencies or organizations possible (1) doctors, (2) hospitals, (3) nursing associations, (4) social service organizations, (5) hospital associations, (6) medical associations and societies, (7) clubs, (8) the police, (9) fire departments, (10) safety organizations (11) boards of health (12) school committees (13) trucking concerns (14) Boy Scouts, (15) Girl Scouts, (16) American Red Cross local chapters (17) industrial accident boards, (18) registrars of motor vehicles, (19) insurance companies, (20) the legal profession.

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complete and is found immediately following the injury when often the nerve is sectioned or a portion of the nerve is destroyed. Injury may occur during the reduction of the fracture by faulty manipulation or unnecessary roughness, or in an attempt to control a struggling patient during incomplete anesthesia. Later during the repair of the bone, the nerve is sometimes involved in the callus, either by inclusion in it with secondary contraction, or by external pressure on the nerve trunk. Hyperesthesia or partial paralysis of motor or sensory function denotes pressure on the nerve trunk. At all times during the process of repair one must constantly be on the alert for these signs of involvement of the nerve and examinations of the arm to test its function should be carried out weekly. During the treatment of these cases prior to reduction, it is imperative to note whether there is or there is not a nerve involvement, and again if present or not, the fact should be determined immediately after the reduction. Prompt and proper recording of these findings will save one some of the tribulations that might follow, if the case goes to litigation.

If the musculospiral nerve is injured early, exploration within a period of 10 days to 3 weeks with suture or other treatment as indicated should be carried out. If the involvement is late, then exploration after the union is solid should be done.

Treatment The principles of reduction are the same as for any other bone, namely, to effect as early as possible an anatomical reposition of the parts. Here, because of non-weight bearing, shortening of an inch or so does not, as a rule, give rise to loss of function, but we feel that the nearer the perfect reduction, the earlier the union and the more perfect the function. This is often best accomplished by traction and countertraction, manipulation, and molding of the parts with the hand. The direction of traction on the distal fragment is made in the direction of the long axis of the proximal fragment with the distal fragment rotated to the same degree as the proximal one.

As has been stated, save for generalities, there is no set position for the upper fragment to assume. Many deformities and displacements are made worse by improper fixation and manipulation immediately after the accident, and during the period of transportation and hospital waiting prior to the taking of x-ray films. During this period in all suspected cases of these fractures, a Murray-Thomas (hinged Thomas) arm splint should be applied with fixation and traction through adhesive plaster and Spanish windlass, as outlined by the Committee on Fractures of the American College of Surgeons. With this fixa-

tion, patients can be readily transported with ease and comfort and certain assurance of not permitting greater displacement or deformity. Often by this primary method, a spontaneous reduction will take place. When properly applied, this splint also permits the examination for blood vessel and nerve complications and allows, within reason, the taking of x-ray films in two planes for diagnosis. If by these films or views one cannot satisfy himself as to the position of the fragments, then a second set of films (stereoscopic type) should be made. Many cases of fracture will show little or no displacement and in these cases we feel that fixation by the application of molded plaster, as will be described later, will suffice.

In the transverse or slightly oblique types of fracture with notching of the ends, manipulation under anesthesia often permits of a ready reduction. This is carried out on a fracture table with the fixed or portable fluoroscope. Certain deformities in certain individuals can be reduced without anesthesia, however, here failure is met with more often than success. The anesthesia is one of choice—novocain locally has its marked limitations; nerve blocking is difficult and not without danger; but we prefer general anesthesia. Ether was our choice until the past year when we have employed the intravenous solution of the barbiturate group with such satisfaction that it is now our preference.

With the study of the x-ray films, the various maneuvers necessary for reduction can be anticipated. This is carried out by flexing the elbow to a right angle, with a firm grasp of the forearm with one hand and the lower third of the arm with the other, while an assistant steadies the upper arm. This maneuver should be carried out in as gentle a manner as possible, so as to prevent further damage. It is our custom and belief that once the fracture is reduced it can best be maintained by the application of molded plaster splints. These should extend, one posteriorly from the level of the knuckles over the wrist, forearm, elbow, arm, and over the shoulder to the level of the scapular border, another anteriorly from the apex of the axillary fold forward to the midpalmar region. After setting of the plaster within 3 to 5 minutes, the entire splint can be supported by a sling. During this procedure the forearm is placed in the position of midpronation and supination, and often at times it is necessary to include or support this splint by the application of a shoulder spica with the plaster extending below the level of the costal margin, thus permitting the placing of the lower fragment and forearm in a necessary or desired position.

FRACTURES OF THE SHAFT OF THE HUMERUS

J HUBER WAGNER M D F A C S , Pittsburgh Pennsylvania

FRACTURES of the shaft of the humerus include all those fractures below the so called surgical neck, marked by the upper level of the insertion of the tendons of the pectoralis major and latissimus dorsi muscles, downward to the level of the supracondylar region or say 1 or 2 inches above the lower articular surface. All varieties of fractures may be found here, varying from the simple transverse, with or without displacement, to the oblique, longitudinal and comminuted types the fracture line extending from a short distance to the entire length of the shaft, with all degrees of displacement of one or more fragments including rotation, angulation and shortening from 1 to 6 inches.

All types of displacement common to fractures of the long bones are found here and no particular type is noted with any degree of frequency. However, in simple transverse fractures at certain levels muscular action at times determines the type of deformity and tends to certain displacements, for instance fractures of the upper third of the shaft above the insertion of the deltoid often present the upper fragment in an adducted position due to the action of the latissimus dorsi and pectoralis major muscles with the lower fragment abducted and overriding the upper because of some traction of the deltoid whereas below the level of the deltoid tendon insertion the upper fragment is abducted by this muscle and the lower fragment is adducted and overrides the upper, due to the action of the biceps triceps and other muscles. In certain types of fracture of the lower third of the shaft, the tendency is toward anterior angulation or displacement of the lower fragment, due to the action of the extensor group of muscles the brachialis brachioradialis and extensor carpi radialis longior.

The force causing the fracture is, we feel the primary and principle agent in determining the type of deformity. Especially is this true in the oblique and comminuted types with secondary displacements caused by improper handling improper splinting of the fragments with the action of the force of gravity on the distal fragment and finally by muscular action.

Causes External violence is the most usual

cause, however these fractures may be caused by direct muscular action. To this end in passing we cannot help but mention the spiral fracture that one occasionally sees resulting from athletic feats—wrestling or trials of strength. These are rare causes when compared with those of direct trauma.

Symptoms The symptoms of the fracture are classical. In this we may include the history of direct injury or accident followed by pain, loss of function, deformity, abnormal mobility and crepitus, and these lead to the final and modern aid in diagnosis, the making of an x ray film of the part. Often these fractures of the humerus are but part of the picture and are complicated or associated with fracture of the clavicle scapula, shoulder, elbow, ulna and radius. It is at these times in the treating of these cases, that the surgeon's skill and dexterity are taxed to capacity.

Complications Directly associated with the fracture are injuries to contiguous blood vessels and nerves. Any injury to the larger blood vessels is rare, especially the brachial artery, but if this vessel is severed or contused with secondary clotting, the pulse is absent. On the other hand if there is pressure of a fractured bone end against the vessel the pulse may be weak. Here one must constantly be on the watch, for generally speaking the greater the degree or severity of the fracture with associated soft part trauma the more apt is the liability of blood vessel involvement.

Nerve injury Because of location, the musculospiral (radial) nerve lends itself to injury. For at least one third of its course in the arm it is found lying in the groove which bears its name and is almost in immediate contact with the shaft of the humerus. It is in this particular location that the majority of the fractures of the shaft occur hence its apparent ready involvement in the trauma. However comparatively it is a rare complication and is variously estimated as occurring in from 4 to 8 per cent of cases. The symptoms of radial nerve injury vary from paresthesia over the sensory distribution in the forearm and dorsum of the hand and thumb to loss of supination, wrist drop and the loss of power of extension of the fingers and thumb. The involvement of this nerve whether immediate or late depends upon whether the paralysis of motion and sensation is

fixation by tap screws. This latter method has been the one of our choice and has been previously presented. Although this method shortens the bone an inch or so, we have never seen any actual loss of function from its use and union takes place in a shorter time than with grafting. In these cases, after proper preparation of the bone, we feel that the principles are the same as the treating of a new fracture and the main point after reduction is fixation. As in simple fractures, we do not count on the internal fixation alone, hence the molded splints are again applied and maintained for 8 to 12 weeks until union is firm.

Motion With the use of the arm splints, the patient is able to be up and about, but with the immobilization of so many joints, muscular atrophy takes place rapidly with the attendant fixation around the joints (peri-articular ad-

hesions). If this inactivity of the muscles persists the circulation diminishes while that of the bone increases. We feel that exercise of the muscles within the splints should be continued. To this end, we have the patient contract the muscles of the forearm by flexing and extending the fingers without force, and by contracting the muscles of the arm without motion. In this way a physiological balance of circulation is maintained and prevents atrophy of muscles and at the same time helps in forming bony union. Active mobilization of the part should not be attempted until union is firm.

There is little if any originality claimed in our methods as presented in this paper. The principles are those used in everyday practice, gleaned from the study of the work of our predecessors and by observation of our confrères.

In certain spiral and comminuted fractures by using the same procedure with prolonged traction or measured primary traction with mechanical aids, such as the Sutter traction apparatus and then manual traction, excellent reductions can be effected and the molded plaster splints applied.

Following the war we attempted the treatment in these cases of keeping the patient prone, with the use of the suspension and continuous traction and countertraction (both skin and skeletal), after the method of Blake and others. However, we found this not only distasteful to the patients, because of the necessary long hospitalization and concurrent expense but unsatisfactory because of the excessive care required in the necessary adjustments, non union occurring quite frequently due to the motion at the site of fracture. To give the impression that this method is now completely excluded, is wrong, as there are the exceptional cases with the attendant shock and other complications which not only permit but require this type of treatment.

In a sense, contradictory to what has been said before, i.e., that many fractures of the shaft despite position, if union is secured lead to good function we believe we should secure as nearly a normal position and alignment as possible. Often because of the interposition of soft parts and other factors—muscle contractions—closed reduction cannot be effected. In these cases we do not hesitate to reduce the fracture via the open method with internal fixation by the use of Sherman plates and screws. The technique is the same as has been advocated for fracture of the femur i.e. the non hand contact technique as advocated by Lane and improved by Sherman and others the details of which I shall omit.

The approach for the open reduction method is by the anterolateral or so called 'Henry' incision. The skin incision is made on a line with the longitudinal axis of the humerus lateral to the cephalic vein. The skin is blocked in the usual manner with towels by the use of the Michel clips and an incision is made through the deep fascia. The biceps is then reflected medially and an incision in the same plane is made through the brachialis anticus down through the periosteum reflecting the periosteum and muscles from the bone giving a neat exposure of the fragments. In this way there is no danger of injuring the radial nerve and as one approaches the lower third the nerve will be found in a groove between the brachialis and the brachial radial muscles. Again one might expose the bone by a posterior incision with reflection of the triceps after method used at the Massachusetts General Hospital.

During the operation, the elbow should be flexed to a right angle to remove the normal muscle tension. In the spiral short or long oblique types after reduction is accomplished fixation can be maintained by one or more transfixation Sherman tap screws. As a rule the longer the fracture line, the less the amount of transfixation necessary, or the fracture can often be held by a single screw properly placed, whereas with the short oblique lines and transverse fractures that are not notched and do not fix readily, bone plates with two or three screws to fix the plate above and below the line of fracture are used. These screws with plates when placed through the proximal cortex give enough fixation. It is unwise to count on internal fixation alone hence following the closure the molded plaster splints are applied and the patient is permitted to be up and about in 2 or 3 days.

Compound fractures are essentially the same as simple fractures save that the force is more severe and the soft part destruction is present to a greater degree. The treatment naturally entails more thought for the soft parts but as for the bone, it is the same as in a simple fracture. In the markedly comminuted fractures extension is carried out with fixation by the use of a plaster cast, whereas in those cases that permit fixation, such as a transverse and oblique fracture, the use of internal fixation is used. This is done at the same sitting as the debridement, and Carrel-Dakin technique is used in the treatment of the wound. Occasionally one has to treat these patients by the use of skeletal traction. Kirschner steel wire or ice tongs are applied with the patient recumbent. We have and prefer to use the body spica with fixation of the lower fragment in the molded plaster splint after transfixation by a Kirschner wire and proper traction. In this way windows can be left or later made in the plaster for treatment of the wound.

Ununited fractures of the shaft of the humerus are seen about as frequently as any other bone. The causes are many by theory such as the interposition of soft parts fracture through a nutrient artery lues, etc. but we feel the most important is the one of improper fixation and again we emphasize the necessity of proper splinting—internal and external—over a period of 8 to 10 weeks. When pseudo-arthritis or non union does occur, two methods of treatment are available. One—bone grafting using an autogenous inlay or onlay graft, transplanted from the tibia or the sliding onlay from the upper or lower fragment and fixation of the graft with tap screws and the other the so called 'step-cut' with

Specialism is a necessary outcome of the complexity of medicine. It is inevitable, and when it arises spontaneously as it should, it is advantageous. Each new specialism is the outcome of some particular need of the time; the existence of a field of work that has hitherto been neglected, the discovery of some new disease or theory of disease demanding intensive study, the need of an unusual technique or the use of delicate instruments, or the rarity of the condition to be studied, so that only by single minded application can a man hope to see enough cases to be familiar with its manifestations. Each is started by the vision and energy of a pioneer or group of pioneers and each will continue to live and grow so long as the need for it is a real one, and so long as the men who practice it are enthusiasts.

Some subjects return to the main body of surgery when the wave of discovery that lifted them from the common level is spent, others remain apart because they seem to be marked out by some convenient boundary of topography, age, or sex, or even by mere force of tradition. These last have advantages brought by all specialization, of intensive study and extensive experience, but they have their own dangers, particularly in the type of man they attract, and the amount of general surgical education which they demand as a preliminary. To found a new specialism requires ability, vision, courage, and a dogged tenacity, for these schisms are always bitterly opposed. It is the founding of a new land and it needs the spirit of a pilgrim father. But to enter one already explored, delimited, and settled, is indicative of the reverse qualities, the wish for a quiet life, freedom from competition, and a steady competence.

Is fracture work a specialty? The orthopedic surgeon will say that it is not a specialty in itself but a part of his own great specialism. I would hesitate to admit his claim without further examination and without at least a struggle. If orthopedics is the treatment of deformities, we say a fracture is not a deformity and never will be if properly treated. If orthopedics includes potential as well as declared deformities, it must eventually treat empyema and gonorrhea as potential causes of scoliosis and ankylosed joints. If it claims the whole locomotor apparatus as its province, it is demanding everything except the serous cavities and has become so vast a subject that specialists must arise within a specialism. Let us reiterate those conditions that demand specialization. Does the treatment of fractures demand a high degree of technical skill? Not skill but rather patience, conscience, and a determina-

tion to treat each case as an individual problem and to persevere with it until the result is as good as it can be. Does it deal with a pathology as yet imperfectly understood? It does not. Does it involve the use of delicate and complex instruments, of a meticulous technique which can be acquired only with difficulty and maintained at the adequate standard by constant practice? Again no. Are fractures so rare that it is necessary to group them in order that any man should see a sufficient number in a lifetime? Would that it were so. Is fracture treatment work that is at present badly done? With shame we must admit that this is the case, and in this admission lies the whole justification for the present demand that fractures should be segregated.

Are there any features that distinguish fracture work and indicate the form this segregation should take? There appear to be three.

First, fracture treatment is the most important branch of surgery, more important than that of the abdomen, far more so than neural or thoracic surgery, for it deals, not with disease, but with the disablement by trauma of a piece of mechanism hitherto perfect, and it should be possible to restore that perfection. In most surgery we have to drain, to modify, to excise, we can accept the nearly right as pretty good, and can share the blame with morbid processes. In fractures all the bits are there and if we put them together they will work again. We cannot in most cases view any loss of function with complacency, anything less than one hundred per cent is not good enough, but when we ask how this is to be done we can say only by hard work and ceaseless self criticism. There is no guaranteed road to success and the most diverse methods will produce good results in the hands of an enthusiast.

Second, fractures are urgent and they occur everywhere. The patient must be treated at once and he must as a rule be treated at or near the place where he fell. He cannot be saved up for the next visit of a traveling expert or transported to a central collecting station serving a large district. For this reason we need a large body of men throughout the country trained to handle fractures competently.

Third, fractures, resulting as they do from trauma, do not necessarily occur as isolated lesions. They often accompany some graver injury such as a cerebral laceration, a ruptured spleen, or a tear of the bladder, conditions demanding knowledge or technique foreign to that of the bone specialist. The training of the man who has to deal with traumatic surgery, to which fractures belong rather than to orthopedics, cannot be too

THE PLACE OF THE FRACTURE SERVICE IN A GENERAL HOSPITAL

W H OGILVIE M A, M Ch, M D (Ox) F R C S (Eng) London England

I AM deeply appreciative of the honor you have conferred upon me in allowing me to speak at the Fracture Symposium of your College. Coming to this conference as an outsider, a visitor to your country for the first time, a surgeon with a lifelong interest in fractures who is yet outside the ranks of orthopedists I feel bound to consider the more general aspects of the problem, particularly that which is concerning us very much at the present time in Britain, the organization of new fracture services.

I had the good fortune to be one of two representatives of general surgery on a committee of the British Medical Association which was appointed in 1935 to consider every aspect of the fracture question as it concerned Britain, and which presented a report to our Government that some of you may have read. The facts which that report brought to light have stirred both medical and lay opinion in our country and have led to a profound discontent with the existing state of things, and a determination to improve it. We may look upon discontent as the mother of progress, but we must remember that she begets change alone and that change is progress not because it brings something new but only when it brings something better.

The facts which were placed before this committee emphasized in a most remarkable manner the difference that lies between good and bad treatment of fractures. We all knew of course that correct treatment will produce better results than incorrect. We were familiar with some excellent series in particular fractures. But I am certain that very few of us were aware till we saw it in the cold logic of figures running into many hundreds and observations spread over many years, of the immense difference that lay between the series representing patients treated in regularly organized services under the control of experts, and those collected from scattered sources and treated by haphazard methods. These analyses did not merely show the contrast between perfect and imperfect anatomical reconstruction between complete and partial restoration

of function: they pointed to a great difference in the two series in the average time elapsed before the patient returns to any kind of work, and a marked divergence in the proportion of those permanently disabled after fractures at any particular site. They provided an estimate of the enormous financial loss that is sustained yearly by insurance companies and by industry as a whole, as a result of partial or permanent disablement that might have been avoided. They emphasized the tragic personal factor of the psychological wreck of fine workmen.

Medical and lay opinion in England is determined largely as the result of the interest awakened by this report, that the treatment of fractures must be put on a satisfactory basis throughout the country and not alone in certain areas. But there is a perfectly definite cleavage between those who advocate the very large clinic under purely orthopedic management designed to deal with all the fractures of a town or district, and those who would organize fracture treatment on the basis of the small unit incorporated in the emergency service of the hospital and employing both general and orthopedic surgeons. We already have representatives of each type and have studied the two systems at work in other countries. The best results we encountered, those given in our report to suggest a standard for emulation were almost necessarily derived from the big clinics, dealing as they do with large numbers carefully recorded and analyzed. The smaller fracture teams which are attached to the accident services in many of our teaching hospitals have no such figures but enquiry suggests that their results are equal to the best. The bad cases quoted for comparison were provided by surgeons or companies dealing with the legal aspects of compensation, and represent a collection picked from many sources for their very badness: the outcome of ignorant treatment or no treatment at all.

This question of the relative value of large or small clinics in fracture work that we are trying to settle is one of some importance. It is not only a matter of the place of specialism in surgery but of the particular demands of the fracture problem and the way they should be met to bring the greatest benefit to our injured fellow countrymen.

From the Fracture Department Guy's Hospital and Royal Masonic Hospital London

Presented at the Fracture Symposium before the Clinical Congress of American College of Surgeons Chicago Oct 25-29 1937

FUNCTIONAL DISABILITIES AFTER SIMPLE FRACTURE

With Special Reference to the Importance of Bone Atrophy in the Prolongation of Disability

FRASER B. GURD, M.D., F.R.C.S. (Can.), F.A.C.S., Montreal, Canada

WHEN the Committee of the College asked me to take part in the fracture symposium, and to present a contribution upon "Functional Disabilities after Simple Fracture," it soon became evident that it was not quite clear just what the title might be considered to indicate. That disabilities persist following simple fractures, and that such disabilities may last for a longer or shorter time, is, of course, axiomatic, that they occur in consequence of anatomic abnormalities, such as shortening, angulation, and rotation deformities and, also, that they follow in consequence of non-union, and of fixation of tendons in the neighborhood of the healing bone, is generally recognized. That in other cases patients remain disabled for a longer or shorter time, although objectively the reason for such prolongation of disability is not easily seen, is less generally appreciated. In consequence, I believe, on the one hand, innocent persons are accused of malingering and, on the other hand, suitable treatment is withheld.

The problem which I propose to consider is why, in a certain proportion of cases, patients whose original injury was not complicated by serious damage to structures other than bone, in which adequate reposition of bone fragments has been obtained, and in which bony union has occurred, nevertheless suffer for a longer or shorter period disabilities which may interfere with their return to their usual vocations. Although it is true that in a small proportion of patients functional disabilities in the sense of hysterical manifestations are exhibited, and although in a somewhat larger percentage of cases a type of disability for which the French (Brouardel) have introduced the term *sinistrose* occurs, it is not my intention to do more than refer to these problems.

The most frequent cause for the persistence or prolongation of disability in the type of case which I have indicated is, I believe, intimately associated with decalcification, osteoporosis, or

atrophy of the bones distal to the injured part, that is to say, the bones of the foot or hand in the case of injuries to the leg and forearm, respectively.

Since the publication in 1926 of a small book by Leriche and Policard in which these authors state their experiments upon and their conclusions regarding the physiology of bone, a number of authors have made contributions to the subject. I refer especially to the contributions of Watson Jones and Roberts, Key, and, more particularly, Greig of Edinburgh. King of Australia disagrees with reference to the relationship of hyperemia to decalcification but, in my opinion, somewhat weakens his case by agreeing that the two phenomena are concomitant.

The normal course of events following bone injury is that on the one hand new blood vessels are formed and an increased blood circulation through the part is exhibited and, on the other hand, decalcification of the bone ends in the neighborhood of the fracture takes place. It would appear evident that the latter phenomenon is exhibited in order to make available at the site of the injury calcium in a form which can be readily utilized in the development of new bone so that repair may be accomplished. As a rule, with the gradual and somewhat rapid maturation of the new connective tissue elements, obliteration of many, or most, of the new blood vessels takes place so that, at first, further decalcification is arrested and, second, the deposition of calcium in the new bone matrix is accelerated.

It does not come within the purview of this contribution to enter into a discussion of the physiochemical problem operative in the deposition of calcium in mesenchymatous tissues in the production of bone. The importance of hydrogen ion tension of the tissue fluids and of the phosphatase concentration in the tissues generally and locally, presents problems which are not, I believe, imperative to the discussion of the question at present under our consideration, nor is the writer competent to express views upon these subjects. It is, however, of importance that we consider the effects of normal, inadequate, and

From the Montreal General Hospital—McGill University.
Presented in the Symposium on Fractures, before the Clinical Congress of the American College of Surgeons Chicago October 25-29, 1937.

wide or too extensive. In some favored centers such work may be undertaken by a team of experts in collaboration. Such a course implies a sharing of responsibility that is not always in the best interests of the patient, and it sets a standard clearly impossible of attainment in country districts.

It appears then that the treatment of fractures demands segregation more because of its importance than because of its difficulty. It should be kept entirely in the hands of those who have the time to devote to it, the energy to study it, the enthusiasm to make themselves personally responsible for its every detail. These requirements fulfilled, the more surgeons who take part in the work, the better. Segregation is certainly necessary but segregation need not imply undue specialization. It demands the grouping of fractures in one department, the unification of all those parts of a fracture service that will gain by centralization but it can allow a very wide distribution of personal responsibility.

In any hospital, possibly in many towns of moderate size, it will tend to increased efficiency to have all the executive services together, that is the roentgenographic and splint departments, the operating and plaster rooms, the secretarial and recording offices and it is equally important that the cases should all be in one group of specially constructed fracture wards and under the care of a common resident staff, nurses, sisters, and junior medical officers. But with such unification of executive control and grouping of material resources, I would plead for individual services of moderate size working side by side.

The upper limit of size in a clinic, in my opinion is that number for which the chief can be personally responsible without delegation. I have not in mind the assistance given by juniors attached for short periods for purposes of instruction, but the work of more experienced men who are permanent parts of the service. Once a size is reached where part of the work must be delegated either the assistant is given so much liberty that his unit is a separate one in all but name, or, more probably, he works under rules of procedure laid down by his chief, and treatment becomes a matter of routine rather than of individual initiative. It is very doubtful whether this apostolic relationship is good either for master or disciple. The one

acquires a stultifying sense of superiority free from comparison criticized by none and eventually unable even to criticize himself. The other learns a monastic acquiescence. The world knows no bigot like the yes man whose chief is on vacation, no orthodoxy so impenetrable as that of the pupil who steps into the shoes of the Great Master after years of subservience. It is indeed a remarkable fact that in those countries where a surgeon may succeed to a chair only where he has grown grey and cerebroclerotic in apprenticeship, the technique of the fathers is visited on the children to the third and fourth generations.

The subject of fractures is too important for us to neglect any step that will secure advance to forbid its training to any to whom it might be open and that is what the really large clinic does. It discourages advance by abolishing competition. It limits the number of men who receive the training of responsibility for excess to one means starvation to others.

Fracture clinics must arise in every large center, with sufficient out patient department, secretarial staff and grouped bed accommodation to deal with all the needs of fractures in that area. Unity will be assured by continuity in the senior nursing and resident staff. In such a unit the surgeon specially trained for fracture treatment, whether he be a general surgeon or orthopedist, will have the most important part, for he will be the pace maker, the touchstone by which the work of the rest is judged, but other surgeons interested or expert in the practice of traumatic surgery should also take their share, even those who profess an interest may be allowed to do so at the beginning for under such conditions of healthy rivalry the half hearted and half interested will soon drop out. No man is so thick skinned that he can see his own work compared unfavorably with that of his colleagues on the undisputable evidence of roentgenograms and function without either striving to do it better or giving it up. And the competition among those whose interest is genuine will tend to mutual stimulation to the comparison of results obtained by contrasting means to the exchange of views gained in travel and to a gradual rise in the level of fracture treatment in that center and in the country as a whole.

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excessive blood supply upon the maintenance, excessive deposit, and absorption of calcium in tissues, such as bone, of which calcium is a normal constituent. Sufficient evidence has been forth coming during the past few years to prove that bone, if subjected to an inadequate blood supply, will become more dense in consequence of an increase in the deposit of calcium. Even more definitely proved is it, I believe, that hyperemia or excessive blood supply is followed by osteoporosis or bone calcium absorption or resorption.

The pathological and biochemical observations which have been discussed, and which are of clinical importance, have been summarized by Watson Jones and Roberts. They state their conclusions the following way:

There is normally a balance between the calcium content and the vascularity of mesenchymatous tissues (which is probably associated with phosphatase activity)

In the case of bone —

Normal circulation	—Normal calcification
Increased blood supply	—Decalcification
Decreased blood supply	—Increased calcification
Blood supply cut off	—Unchanged calcification

If, in consequence of repeated attempts at reduction or of inadequate fixation stimulation of hyperemia is prolonged, the process of halisteresis is not arrested and gradually, although in some cases comparatively rapidly, as in acute bone atrophy such as has been previously described by the author (3, 5), and by others (1, 10) continued decalcification of bones distal to the site of the fracture occurs.

Although in the unusual case of acute bone atrophy it is perhaps comparatively easy to explain why and how hyperemia and consequent rarefaction develops, it is a fact that in a comparatively large proportion of fractures more or less atrophy of the bones distal to the site of the fracture occurs. It is to this phenomenon that the expression disuse atrophy has been applied. I wish to suggest as an explanation for such cases that if a limb receives a normal blood supply and at the same time does not function, there exists for all practical purposes a nimity of circulation.

Normal function with normal blood supply	Less than normal function with normal blood supply
—adequate circulation	—relative hyperemia

It will be noted that the foregoing equations attempt a simple explanation for what has been commonly described as the atrophy of disuse, since it would appear that when a bone receives more than an adequate blood supply, decalcification is inevitable.

In the present contribution I wish to urge that whereas in acute bone atrophy of the Sudeck type the clinical signs are clear and the disability in so far as the limb involved is concerned is absolute, there nevertheless is frequently exhibited a degree of atrophy which, although not characterized by the same impressive clinical appearance, is important in prolonging disability.

At a meeting of the Orthopedic Section of the American and Canadian Medical Associations at Atlantic City in June, 1935, I made the following statements: 'Although in consequence of the ease with which the condition is demonstrated by means of roentgenographic examination, the osteoporotic lesion in the bone is most easily identified it should, I believe, be borne in mind that the bony change is but one proof of acute atrophy of other structures. Particularly, I believe, the atrophic changes in the ligaments and their attachments about the joints and in the cartilage covering the ends of the bones in the articulations deserve special attention in an effort to elucidate the problems of cause, prevention and cure of acute bone atrophy.' I wish to extend this thesis so that it may apply to the less marked and clinically less impressive type of bone atrophy such as commonly occurs, and to which the phrase disuse atrophy has been hitherto applied.

The explanation for disability in the presence of decalcification of the bones of the foot and hand respectively is due, I believe, to the fact that when the bones become softened, the attachment of ligamentous and tendinous structures becomes insecure. The result of such insecurity is that when strain in consequence of either weight bearing as in the case of the ligaments and tendons of the foot, or of tendon pull and, to a lesser extent, ligamentous strain in the case of the wrist and hand, is exerted, a tendency toward, or actual detachment of either ligament or tendon as the case may be, from the bone to which it should be securely fixed, takes place.

In our laboratory at The Montreal General Hospital the observations of Dr. Joseph Pritchard, who has for a number of years carried on an investigation into the nature and origin of bone, cartilage, and tendon tumors, have been successful in proving I believe that the usual conception with regard to tendons and ligamentous structures, that they have their origin in and consequently as it were, they belong to the muscles is wrong. Dr. Pritchard's observations prove I believe that ligaments and tendons do, in fact, arise from the osteoblastema and consequently throughout the lifetime of the individual are a part of the bone (Fig. 1).



Fig 1 Photomicrographs, low and high magnification, from Dr J E Pritchard's collection showing osteoblastema forming bone on the one side and tendon on the other



These photographs support, we believe, Dr Pritchard's hypothesis that tendons and ligaments having the same origin as bone take part in the same regressive changes

When, as the result of trauma, these structures are injured, they exhibit a tendency to revert to the primitive osteoblastematous form, even to the extent of becoming myxomatous. It may, therefore, be assumed that when roentgenographic examination proves bone atrophy to have taken place, not only have the attachments of the tendons and ligaments become insecure but that, in addition, the latter structures have themselves become less stable.

The clinical diagnosis of acute bone atrophy can be made on a basis of typical signs and symptoms. Comparatively soon after an injury which is usually trivial and is commonly in the neighborhood of the hand or foot, the extremity rather suddenly becomes swollen and painful, particularly upon movement. The skin loses its normal markings and becomes glazed in appearance and discoloration of a dusky red is seen. The joints become stiff and movements are exquisitely painful.

With absolute rest, particularly if dispersion of the interstitial edema is at the same time obtained, relief from pain follows.

Roentgenographic examination made within a few days of the onset of the clinical phenomena just described shows characteristic patchy areas of almost complete decalcification of the bones. This is most marked in the small bones of the wrist or tarsus and in the extremities of the metatarsal or metacarpal bones and the phalanges. As the lesion progresses, the rarefaction becomes more complete in so far as the small bones and the cancellous tissues of the long bones are con-

cerned, so that the patchy appearance is lost, and marked rarefaction in the shafts of the long bones also becomes evident. This is the chronic, second stage.

The view which I wish to support at the present time is that, although in numerous cases in which the hyperemia stimulated is less marked and the objective clinical manifestations are not impressive, nevertheless, in so far as the ultimate bone changes are concerned, the rarefactive process may progress sufficiently to render the attachments of ligaments and tendons insecure. In other words, I am of the opinion that it is possible for the condition, which has been previously referred to as the chronic stage of bone atrophy, to be reached without the acute stage having been noted.

The change in the bone which is brought about by hyperemia, and which is recognized most easily by radiological examination, is, I believe, characterized by a reversion of the osseous structures to a more primitive form (osteoblastema).

Since the cartilage covering the bone ends, the ligamentous structures, and the tendons attached to the bones, has, in fact, the same embryologic origin, it is to be expected that similar reversion changes should occur in these structures.

Owing to the fact that operative interference even for the purposes of obtaining tissue for biopsy is not justified or indicated in the great majority of cases in which localized post-traumatic osteoporosis is present, no one has hitherto been in a position to make positive statements with regard to the actual changes which are commonly present

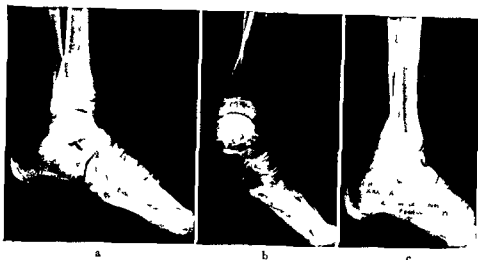


Fig 2 H H Sprained ankle in December 1936 Foot was placed in dangling padded plaster for 5 months a Normal foot for comparison b marked hallux valgus July 1937 c recalcification August 18 1937 following active movements and weight bearing with crutches

In consequence of a diagnosis of tuberculous arthritis having been made in connection with a recent case, it was deemed advisable by Dr James Shannon, under whose care the patient was being treated, to remove a small portion of the anterior border of the tibia at the ankle joint together with a small amount of attached capsule. Histological examination of the tissues so obtained proved useful, in the first place because it proved the absence of tuberculosis and in the second place is of especial interest to us in that evidence of reversion of both bone and ligamentous tissue to an embryonal type is shown by the sections

H H No 280637 Age 12 years Injury was a twisted ankle while skating in December 1936 Patient walked on painful ankle for 1 month Doctor diagnosed tuberculosis of ankle. Limb was placed in padded plaster dangling for 5 months

First seen by us July 1937 The foot was somewhat swollen and tender X ray examination was made and marked diffuse osteoporosis was noted Patient was discharged from hospital to return in 1 month In the meantime walked on ankle using crutches Examination August 23 showed slight diffused swelling about foot but no tenderness

Limitation of movements of the foot and ankle joint still present though improved 1000 old tuberculin examination negative X ray examination showed recalcification progressing

September 3 biopsy of left ankle September 14 wound was clear sutures were removed Patient continued to exercise foot and leg in bed until September 20 when he was allowed up Further X ray examination was made September 20 He was discharged from hospital September 28 Recent October 17 1937 report states that he is free from symptoms and disability (Fig 2 a b c and Fig 3)

Over a period of many years the author has had the opportunity of examining a comparatively large number of problem cases These have been referred either by insurance companies, Workmen's Compensation Commissions or individuals who believed that adequate consideration of their disabilities had not been forthcoming In a very large proportion of such cases the differences of opinion existing between the injured person and the body financially responsible have been due to the fact that although no obvious cause of disability had been noted upon examination, the victim has, nevertheless found it difficult, or impossible to carry on with his work In by far the greater proportion of such cases the cause of disability has been found to be due to bone atrophy

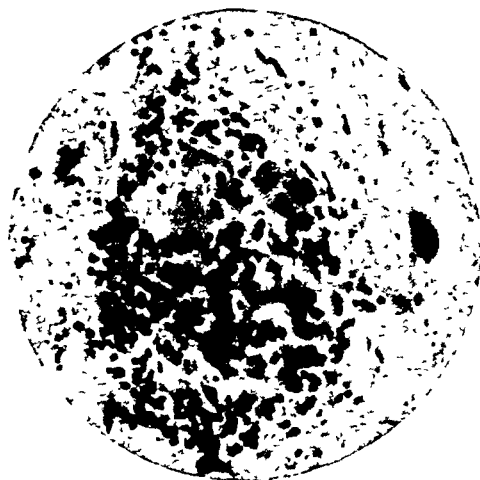
The following case exemplifies I believe the major thesis of this contribution

Mr L T aged 35 years was injured October 13 1936 as the result of an accident in a mining shaft He was treated by Dr J L McArthur of Noranda Quebec for a fracture of both bones of the leg at the junction of the middle with the lower third complicated by a small compound injury (infection did not occur)

He was first seen by me January 20 1937 at which time union of the bones had been found to have progressed satisfactorily the wound was substantially healed X ray examination made February 23 that is a little more than 4 months from the date of the accident during most of which time the patient had been treated in padded plaster of Paris showed the bones at the site of fracture to be in perfect position The patient was however unable to bear any weight on account of pain in the foot Later x ray examination of the foot showed marked hallux valgus as shown in the illustration



Fig 3 Photomicrographs of fragment of ligament and bone removed from anterior border of the ankle-joint, in case of H H Left, Low power, shows regressive changes in



ligamentous tissue, right, high power, shows large mononuclear cells and localized area of lymphoid and plasma cells infiltration

An unpadded walking plaster including the knee (of the Gurd (4) type) was applied, and by May 26 recalcification of the bones of the foot was proved to have taken place by x-ray examination, and weight bearing without plaster was commenced. By the end of June, although the limb was still somewhat weak, the man was able to return to somewhat protected work (Fig 4)

The results of treatment appear to prove that the process of both acute and chronic bone atrophy is reversible, the length of time required to bring about clinical cure is likely to be prolonged for from 6 months to an even longer period

With reference to treatment, I believe that the most important memorandum is that pain should be avoided and, more particularly, that anything in the nature of forcible manipulation, either with or without an anesthetic, should be excluded

"In the case of the upper extremity, if further insult to the tissues is avoided the course is toward repair. The patient should be warned that no painful movements of any sort should be undertaken. I have employed both snugly fitting, unpadded plaster casts and physiotherapeutic measures, especially hot bathing¹ at home. In the case of the lower extremity, I am convinced that the unpadded walking plaster cast, which is applied after absolutely all interstitial edema has been disposed of, and to which a felt heel has been added, is the method of choice. If care is applied to remodel the foot, particularly with reference to

overcoming pronation and flattening of both arches, and if the patient walks sufficiently, the results are satisfactory."

Although early active exercise has been, and is, successfully employed by but a small number of surgeons, in general I am convinced that absolute fixation of the fracture with functional activity of the extremity induced without movement of the joints in juxtaposition to the fracture is both more easily and more safely carried out.

It must be clearly understood that massage when employed in the treatment of fractures does not include passive movement. Massage should be used, I believe, only for the effect upon the blood supply to the limb. Since, in the majority of cases in which massage would seem to be indicated, the local blood supply is excessive, the

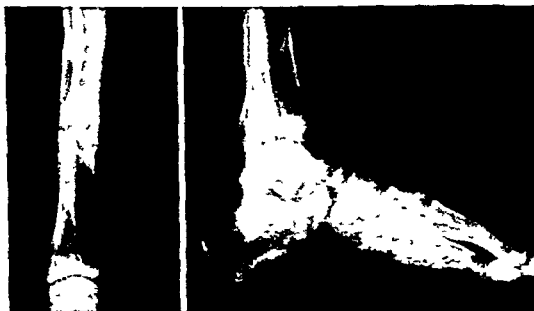


Fig 4 L T Fracture of both bones of the leg, October 13, 1936. Roentgenogram, February 22, 1937, shows bone atrophy of all bones of the foot. Left, soundly healed fracture line, right, halstheresis of bones of foot

¹The application of heat, we believe, is primarily useful since it increases the local metabolic processes and consequently tends to render the blood circulation in the part inadequate and so to stimulate recalcification

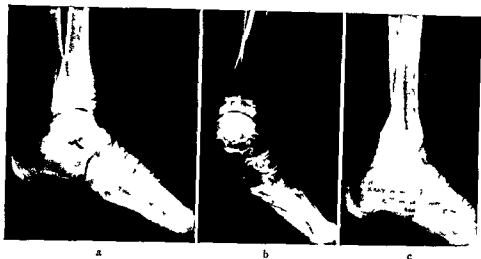


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TWO-PLANE DIRECTION FINDER FOR NAILING FRACTURES OF NECK OF FEMUR

GILSON COLBY ENGEL, M.D., F.A.C.S., and HANS MAY, M.D., Philadelphia, Pennsylvania

WHEN Dr. Hans May and I, working on the service of Dr. George P. Muller at the Lankenau Hospital, began nailing fractures of the femur after the method of Smith-Petersen or Watson-Jones, several things impressed us that called for improvement: first, the difficulty in getting two-plane direction for the nail in its course through the neck of the femur, second, the extensive incision, the cutting of muscles which involved bed immobilization for these elderly patients, third, the shock in these patients from a prolonged extensive operation, and last, loss of function or poor return of function due to long immobilization.

We began to search for a means to correct these bad features. The thought struck us that if we could have a perfect two-plane direction finder we could work through a small incision extra-articularly using the guiding wire after Johansson to thread our nail upon.

From the Lankenau Hospital, Service of Dr. George P. Muller
Presented in the Fracture Symposium, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937

With this in mind we got a clue from Kuent-scher, of the University of Kiel, who had utilized an aluminum plate with metal lines consisting of steel which would stand out under the x-ray. Using this idea of the lines and two different types of metal, we planned a two-plane direction finder which would give perfect two-plane position and which would contain tubes through which the Kirschner wire could be fed.

The methods previously reported if simple were grossly inadequate for accuracy; if they were accurate they were too complicated and involved complicated technique. We, therefore, realized that any instrument to be worth while must contain two features—simplicity and accuracy. This was always kept in mind.

By means of the direction finder which we received only about 3 weeks ago and which we have used on 2 patients, 73 and 76 years of age, we can do the whole operation through a small incision and can complete the operation in 20 minutes. The incision is made only so large that the impactor, used at the end of the opera-

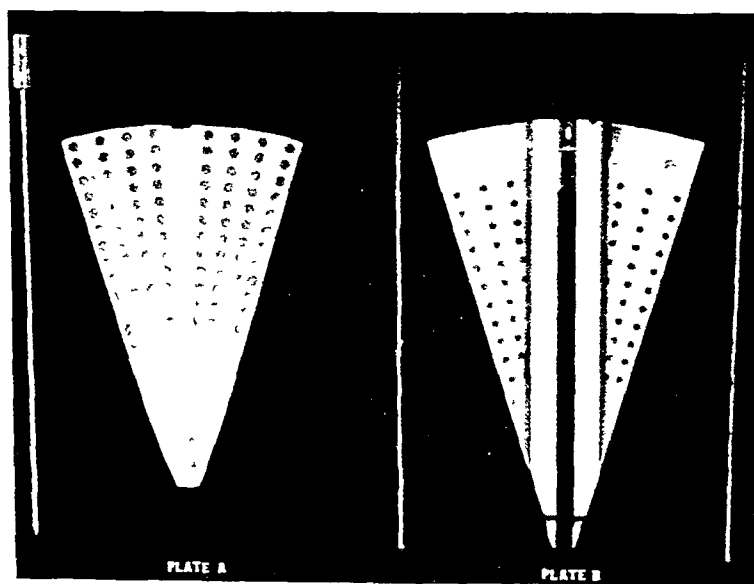


Fig 1. Front view of the two-plane direction finder with pins for fastening.

effect of massage should be to stimulate the muscles to activity so that the available blood supply will be relatively exhausted. Under no circumstances whatever should massage cause even the slightest amount of pain.

Although forcible manipulation to re-establish joint movement may very occasionally serve a useful purpose, the author is of the opinion that, in general, the harm done by such manipulation enormously outweighs the usefulness obtained.

SUMMARY

The author brings forward the point of view that one of the most common causes for prolongation of functional disability following simple fractures is due to bone atrophy associated as it is with regressive changes in tendons and ligaments. He is of the opinion that such atrophy is the result of hyperemia or a diminution of blood supply to the part.

The chief cause for persistence of hyperemia in the injured limb is repeated or continued irritation at or about the site of fracture.

The two main causes for continued irritation appeared to be operative:

1. Inadequate fixation, i.e. (a) application of padding which shifts its position and permits movement with consequent stimuli (b) a dangling limb.

2. Too short a period of absolute fixation so that pain stimuli become operative after removal of support and attempted function of the unprotected member.

The author has attempted to establish as his major thesis in the prevention of functional disabilities following simple fracture the principles of sufficiently long fixation together with the establishment of function as completely and at as

early a date as possible while the fracture line and joints in proximity remain at rest.

a. In the case of the lower extremities, the major function is weight bearing; therefore protected weight bearing should be accomplished with as few days' delay as possible.

b. In the case of the upper extremities, the major function is delicacy of movement which in turn depends upon joint and tendon function, particularly of the fingers and thumb. Absolute fixation, therefore of the fracture area with as great freedom as possible of the fingers is the *desideratum par excellence*.

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Fig 5 Lateral view of femur with Plate B in position and the wire introduced through the tube corresponding to the proper row of dots

lower point of the trochanter is palpated and the incision is made from this point down the lateral aspect of the thigh paralleling the femur for 2 inches. The incision is carried down through skin, subcutaneous tissue, tensor fascia lata, vastus lateralis, to the bone through the periosteum

X-ray view with plate A in position

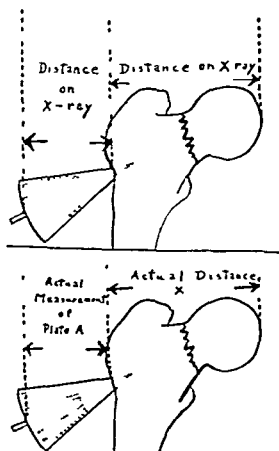


Fig 7

Fig 7 Sketch which shows how calculation is made for proper length of nail

Fig 8 Anterior view of an intracapsular fracture of the

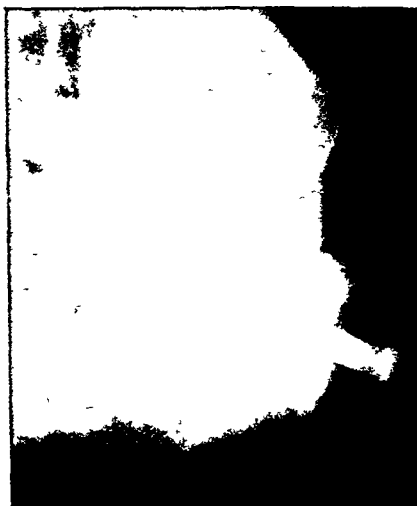


Fig 8

neck of the femur after reduction and insertion of the Smith-Petersen nail

Fig 9 Lateral view of same case as in Figure 8

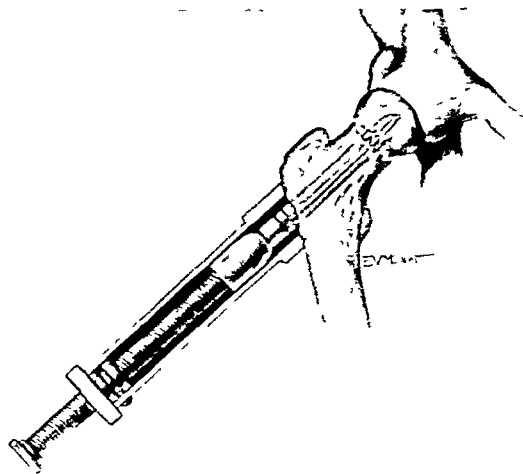


Fig 6 The Smith-Petersen nail is in place and the impactor is screwed onto the head of the nail. The neck impactor is set up against the lateral cortex of the femur so that a blow by hammer on the cap will impact nail and neck at the same time

There is practically no bleeding from this incision. The apex of Plate A is introduced into the incision with the plane parallel to the shaft of the femur pointing just a little upward into the notch formed by the junction of the shaft with the lower border of the great trochanter. Its pin is then inserted and driven into the cortex of the bone fixing Plate A in position. An anteroposterior x-ray plate is then



Fig 9



Fig 2 Assembled instrument with fixing pins in place

tion, can be inserted (2 inches). The patient is allowed to move his leg at once and is up in a chair 48 hours after operation.

The instrument is composed of two plates made of aluminum in sector shape (Fig 1). The one plate we designate as Plate A, the other as Plate B. Plate A has rows of steel dots converging to the apex. Through the center is a hole in the long axis through which a pin is placed to fix it to the femur. Plate B is similar in shape, with a slot passing through its center in the long axis almost to the circumference. This slot which takes Plate A when the two plates are at right angles to each other is reinforced on either side and these reinforcing strips have holes through them in the long axis to take two pins to fix Plate B in the femur. This plate also has converging rows of dots toward the apex. In the long axis of this plate are tubes underlying the rows of dots which will take a Kirschner wire.

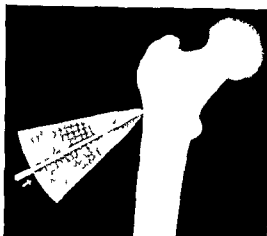


Fig 3 Anteroposterior view of femur with Plate A in position. The arrow indicates the line of dots which are in line with the axis of the neck of the femur.

As to the method of use of this direction finder, the patient is first given spinal anesthesia and then placed on the fluoroscopic table with the affected side near the edge of the table. The fracture is then reduced under the fluoroscope by means of the Leadbetter manipulation. The leg finally put in extension abduction and slight internal rotation is held there by an assistant. The skin over and below the great trochanter is prepared and the field of operation is draped. The

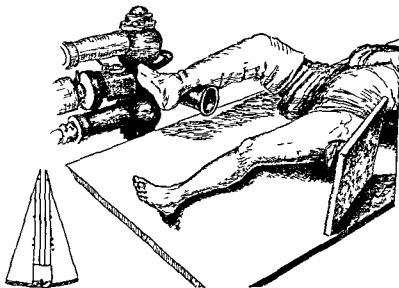


Fig 4 Method of taking lateral roentgenogram of neck of the femur with Plate B in position.



Fig 5 Lateral view of femur with Plate B in position and the wire introduced through the tube corresponding to the proper row of dots

lower point of the trochanter is palpated and the incision is made from this point down the lateral aspect of the thigh paralleling the femur for 2 inches. The incision is carried down through skin, subcutaneous tissue, tensor fascia lata, vastus lateralis, to the bone through the periosteum.

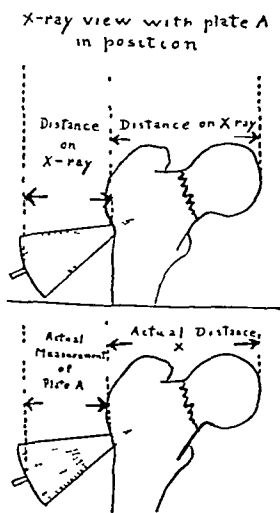


Fig 7

Fig 7 Sketch which shows how calculation is made for proper length of nail

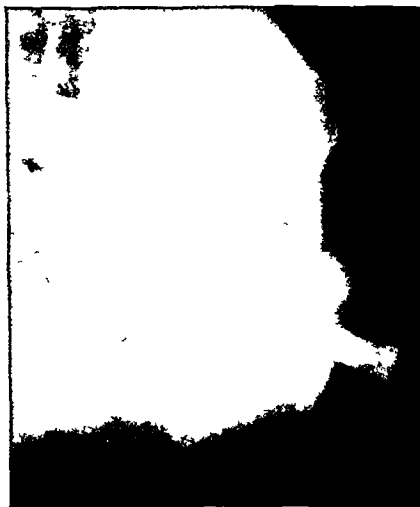


Fig 8

neck of the femur after reduction and insertion of the Smith-Petersen nail



Fig 9

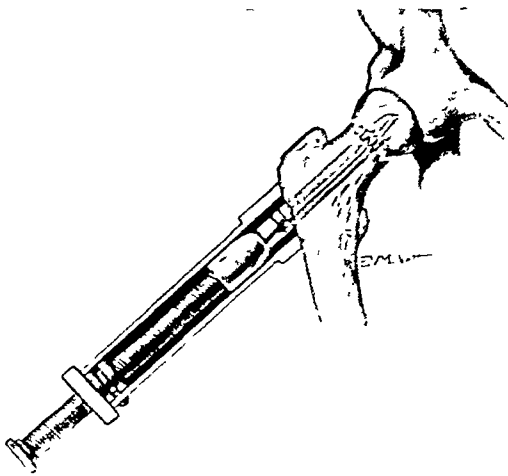


Fig 6 The Smith-Petersen nail is in place and the impactor is screwed onto the head of the nail. The neck impactor is set up against the lateral cortex of the femur so that a blow by hammer on the cap will impact nail and neck at the same time

There is practically no bleeding from this incision. The apex of Plate A is introduced into the incision with the plane parallel to the shaft of the femur pointing just a little upward into the notch formed by the junction of the shaft with the lower border of the great trochanter. Its pin is then inserted and driven into the cortex of the bone fixing Plate A in position. An anteroposterior x-ray plate is then

Fig 9 Lateral view of same case as in Figure 8

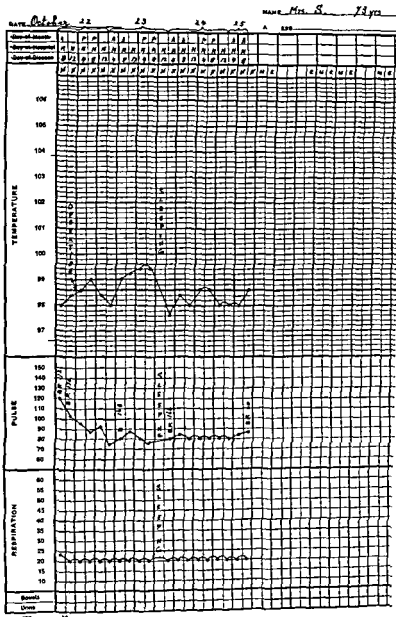


Fig 10 Postoperative chart of patient shown in Figures 8 and 9

taken, and is developed in 2 minutes by placing it in a warm and concentrated developer (Fig 3). The line of dots which are in line with the axis of the neck of the femur is selected for proper direction in this plane. Plate B is slid over Plate A at right angles to it and swung over an arc until it overlies the selected row of dots in Plate A.

Plate B is then fixed in position by its two pins being introduced into the cortex of the femur. The pin of Plate A is then withdrawn and Plate A is removed by sliding it out of the slot in Plate B. A lateral roentgenogram is then taken with just Plate B in position (Fig 4). Again the line is selected which is in proper direction to go

through the axis of the neck of the femur. As soon as this row of dots is selected a Kirschner wire is introduced into the tube corresponding to the row of dots and drilled into the neck to its head (Fig 5). Plate B is then removed and its two pins are withdrawn, leaving only the Kirschner wire in place in perfect position. The Smith-Petersen nail is then introduced over the wire and driven into the head. As the nail is partly in we impact the fragments with an impactor. This is exceedingly important (Fig 6).

As to selecting the length of nail, we take our first x-ray film of the fracture with Plate A in position. We know the actual length of Plate A and from this we get the length of the nail needed (Fig 7). Actual length of Plate A is to the measured length of Plate A in x-ray film as X distance between lateral edge of femur and the head is to this same distance in the x-ray film. The wire is then withdrawn and about three skin sutures placed in the incision and a small dressing applied. Final check is made with an antero-posterior and a lateral plate for position (Figs. 8 and 9). The patient is up in a chair 48 hours after operation (Figs. 10 and 11).

The points we would like to stress regarding this device are. (1) its real simplicity, (2) the accuracy of the method, (3) the small incision—no muscle cutting—no shock, (4) the short duration of operation; (5) patient starts motion at once; (6) patient is up in chair after 48 hours, (7) no atrophy of disuse.

We present this description of the instrument as a preliminary report. We feel that it will cut down still more the mortality in this type of fracture, first, by the simple, short, non-shocking operation, and, second, by making it possible to get the patient up early, we believe also that it improves the functional end-results by early motion.

SUMMARY

A description has been given of a two-plane direction finder to facilitate the introduction of wire into the femur neck in nailing intracapsular

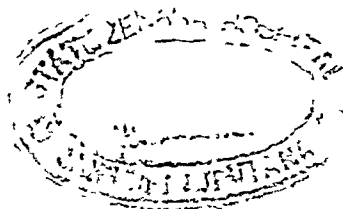


Fig. 11 Same patient 2 days after operation

fractures after the Smith-Petersen and Sven Johansson methods. The technique has been described in detail.

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FRACTURES OF THE BONES OF THE HAND

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THE subject of this paper is not of my own selection. A discussion of fracture of any other bone would have been more welcome, my reason being that I have neither a controversial argument to present nor any new suggestion. The question of fracture of the metacarpals and phalanges may be timely as there are not only very few articles on the treatment of fractures of these bones but also I cannot recall a practical demonstration of the method of the treatment of fractures of the phalanges and metacarpals at any meeting of the Pennsylvania State Medical Society, the American Medical Association, or the American College of Surgeons nor can I remember a presentation of this subject being made at any meeting of our central or regional fracture groups. The treatment of fractures cannot be taught with any papers, essays, slides, or films. Practical demonstration is the best method of proper instruction. Through the medium of intensive propaganda along educational lines the sequence of the treatment of a fracture of a long bone is fairly well established. First aid treatment has been duly emphasized and the subsequent methods of permanent dressings discussed at length. There has been no similar emphasis placed upon the treatment of fractures of the bones of the hand.

The treatment of fractures of the bones of the hand has been ably described by McNealy and Lichtenstein with a report of 1323 cases. This

paper was presented before the meeting of the Western Surgical Association in 1934 and was admirably discussed by Magnuson and Speed.

Comparatively few articles dealing with fractures of the hand have been published.

Fractures of the bones of the hand unless associated with more serious injuries are usually treated in the out patient dispensary. If the personnel of the out patient dispensary is under the direct supervision of one interested in and competent to treat fractures, the end results will be satisfactory. Out patient dispensaries are not always properly supervised. The treatment of all fractures should be under the supervision of one directing head whether the injured be a ward or a dispensary patient.

The mechanism of the hand is complex. Its usefulness depends upon the contour of the bony frame, the freedom of motion of the 15 involved joints, and the proper action of muscles and tendons. In some occupations ankylosis of one joint of a finger may impair the usefulness of the whole hand and seriously handicap the patient's ability to pursue his livelihood.

The treatment of fractures of long bones may, if I might use the expression, be more spectacular although of no greater importance. In teaching medical students we may have laid too much emphasis on the treatment of fractures of long bones to the neglect of the treatment of fractures of the hand. Far too often we find a tongue

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Presented at the Symposium on Fractures before the Clinical Congress of the American College of Surgeons, Chicago, October 23-29, 1937.



Fig 1 Mushroom fracture



Fig 2 Fracture of distal phalanx—separation of fragments

Fig 3 Reduction



Fig 4

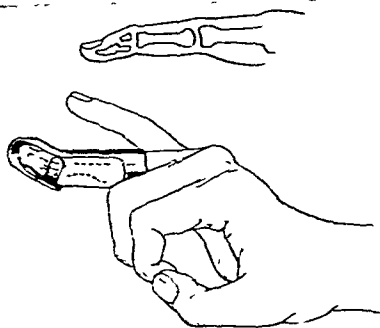


Fig 5

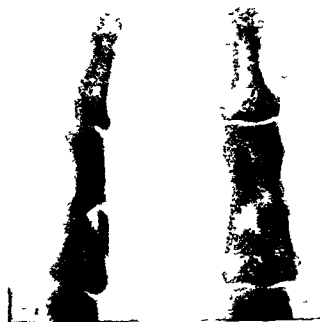


Fig 8

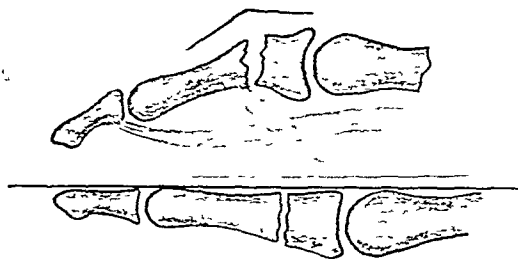


Fig 6

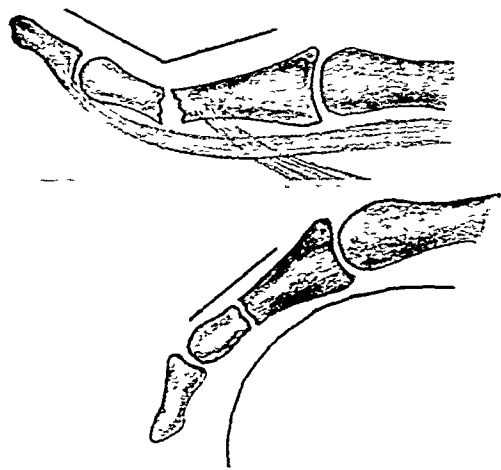


Fig 7

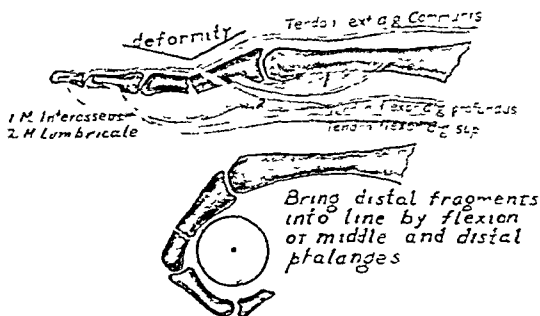


Fig 9

Fig 4. Fracture of dorsal facet distal phalanx commonly called "baseball finger"

Fig 5. Lewin "baseball finger" splint.

Fig 6. Treatment of fracture of middle phalanx—line of fracture proximal to insertion of flexor sublimis digitorum.

Fig 7. Treatment of fracture of middle phalanx—line of fracture distal to insertion of flexor sublimis digitorum.

Fig 8. Compound fracture of middle phalanx caused by gunshot wound treated by débridement and wire extension through soft tissues of distal phalanx.

Fig 9. Showing treatment of fracture of proximal phalanx complicated by V-shaped deformity due to action of interosseous muscle on proximal phalanx and extension of the distal fragment by the lumbrical muscle.

danger of striking a person with their fists. This special emphasis is stressed to prevent the lacerated wound of the knuckle caused by a tooth cut. Complications and sequelæ following this type of injury are well recognized.

The most common cause of compound fracture of the metacarpals and phalanges occurring in the police department is gunshot wound.

To evaluate properly the deformity of any fracture one should be familiar with the action of the muscles controlling the fragments. This does not necessarily mean that all fractures, even though sustained at the same level with regard

depressor used as a splint for all fractures of the phalanges and a roller bandage as a panacea for fractures of the metacarpals.

Fractures of bones of the hand are not as frequently sustained by the personnel of the police and fire departments as one would expect. The police are warned in their first aid lectures of the



Fig 10 Showing 'cock up' position of hand Traction applied for fracture of phalanx

to the origin or insertion of muscles are followed by the same deformity of fragments. The direction of the force causing the fracture may influence to a considerable extent the resulting position of the fragments.

A frequent type of fracture of the distal phalanx is the mushroom fracture—a comminuted fracture caused by a blow or crush of the distal phalanx of the finger, often associated with a hematoma beneath the nail (Fig 1). The patient presents himself with symptoms of a swollen, painful finger. The hemorrhage beneath the nail is recognized and the blood is evacuated. The fracture may be overlooked. The patient may be allowed to resume his work in a few days but returns to the surgeon shortly afterward because of continued pain and tenderness. An x-ray picture may then reveal the fracture. It is imperative, especially in industrial cases, to roentgenograph all injuries of this character.

A fracture through the midportion of the distal phalanx may be associated with separation of the

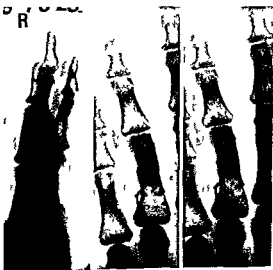


Fig 12 Pathological fracture of proximal phalanx fourth finger through bone cyst



Fig 13 Pathological fracture through area of osteomyelitis middle phalanx index finger

fragments. The distal fragment may be easily restored and held in contact with the proximal fragment if reduction is made immediately. Subsequent displacement is rather unlikely (Figs 2 and 3).

A simple fracture of the distal phalanx may be treated with the use of a wooden tongue depressor as a splint.

Whereas Smith and Rider have shown that the average time for bony healing of the complete phalangeal fracture is approximately 5 months, yet one naturally does not keep these fractures at rest for this length of time. Immobilization on a splint for 10 days or 2 weeks suffices.

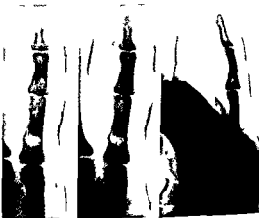


Fig 14 Pathological fracture through bone cyst of proximal phalanx of fifth finger



Fig 14 Transverse fracture of distal end of third metacarpal caused by blow with fist.

A compound fracture of the distal phalanx is treated by débridement. Removal of the nail must depend upon the degree of devitalization of soft tissues and the amount of remaining attachment of the nail. If the soft tissues are badly devitalized and the nail practically detached, it should be removed. If the nail is still attached to fairly healthy soft tissues it may be retained, thereby serving as a partial splint.

In compound fracture of the distal phalanx necrosis of the detached fragment may ensue.

The most difficult fracture of the distal phalanx to treat is the so called "baseball finger." In this type of fracture the posterior articular facet is detached by the pull of the extensor tendon. Failure to correct this deformity may result in the "drooping" finger causing impairment of motion. Fracture of this type should be kept at rest on a splint with the distal phalanx in hyperextension for at least 4 to 6 weeks (Figs 4 and 5).

In the treatment of fractures of the middle phalanx one should consider the insertion of the tendon of the flexor sublimis digitorum regarding the line of fracture. If the line of fracture occurs proximal to the insertion of the tendon the resulting deformity may be readily corrected with a straight dorsal splint, the finger being held in extension (Fig. 6).

If the fracture occurs distal to the insertion of the sublimis tendon the deformity is more readily

corrected with the finger held in flexion (Fig 7). After 10 days at rest, active motion of the finger may be employed at the time of each dressing. The splint should not be permanently removed for 3 weeks.

One should never attempt to elicit crepitus to make a diagnosis of a fracture of a phalanx. This rule applies to a fracture of any other bone of the

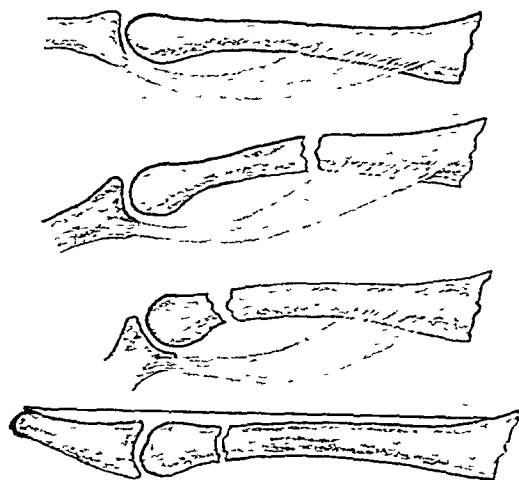


Fig 15 Transverse fracture of metacarpal showing action of interosseous muscle



Fig 16 Soft tissue traction for fracture of metacarpal

skeleton Attempting to elicit crepitus may disturb the position of the fragments—disturb a favorable position of the fragments—and render the treatment far more difficult

A compound fracture of the middle phalanx associated with devitalization of soft tissues may require debridement and soft tissue or skeletal traction Traction is also employed in the treatment of interarticular fracture, the line of fracture extending either into the joint between the midphalanx and distal phalanx or between the midphalanx and proximal phalanx (Fig 8)

Soft tissue traction cannot be applied to the distal phalanx In the treatment of fractures of the middle phalanx requiring traction one employs traction utilizing a strand of silkworm gut or wire through the soft tissues of the distal phalanx or skeletal traction with wire or pin through the bone itself We prefer either of the above methods to traction with wire passed through the finger nail

Fracture of the proximal phalanx may be complicated by a V shaped deformity due to the action of the interosseus muscle on the proximal phalanx and extension of the distal fragment by the lumbricale This fracture should be immobilized with the finger held in flexion (Fig 9)

When traction is applied to fracture of any phalanx, the hand must be held in the cock up position If traction is applied with the finger or fingers in complete extension there is an im-

balance of muscle pull which may result in malalignment of the finger (Fig 10)

Pathological fractures of phalanges are not frequent Such fractures may complicate osteomyelitis, bone cysts, or other pathological lesions of bone (Figs 11 12 and 13)

Fractures of the metacarpals are either transverse or oblique The transverse fracture occurs at the distal end of the metacarpal bone just proximal to the head This injury is usually caused by a blow with the fist Unless the existing deformity is corrected obliteration of the knuckle may ensue The fracture should be reduced under anesthesia A straight dorsal splint may suffice, but if the deformity tends to recur traction is imperative This type of fracture, as well as the transverse or oblique fracture through the middle of the metacarpal may be erroneously treated by flexion of the hand over a roller bandage a position which aggravates the existing deformity (Figs 14 and 15)

If the fragments of a fracture of one or more of the 4 inner metacarpals cannot be retained by a posterior splint traction on the phalanges may be employed Soft tissue traction is adequate in the majority of cases Traction may be applied by one of 4 methods lateral and circular strips of adhesive plaster a narrow bandage or tape fastened to the finger with Sinclair's glue or paste silkworm gut or wire passed through the nail or skeletal traction applied by means of a Mock finger caliper or stainless steel pin

In the application of soft tissue traction the distal phalanx must be protected otherwise, excessive pressure over the finger nail causes pain or may cause sloughing of the soft tissues

There are many types of splints on the market for the application of skeletal traction Most of these splints are cumbersome and expensive An adequate fixation splint may be made with plaster of Paris incorporating the forearm (Figs 16 17, and 18)

Fractures of the first metacarpal involve either

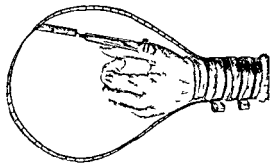


Fig 17 Metzler apparatus for skeletal traction



Fig 18 Metzler apparatus for skeletal traction

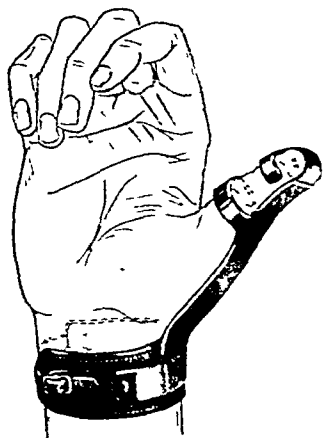


Fig 19 Lewin Stern thumb splint

the shaft or the base of the thumb. Fracture of the shaft of the first metacarpal is not a frequent injury and when incurred is due to direct violence. This type of fracture is given treatment similar to that of fracture of a phalanx rather than to a fracture of one of the 4 inner metacarpals. The thumb is immobilized in adduction and partial flexion or in the grasping position. Such position may be maintained by the application of a light plaster-of-Paris cast to the wrist and thumb.

Comminuted fracture of the shaft of the first metacarpal may require traction—either soft tissue or skeletal. Traction must be applied so as to maintain flexion in adduction of the thumb.

The more common type of fracture of the first metacarpal is fracture of the base of the thumb which may be an impacted fracture not involving the articular surface or an oblique fracture in which the line of fracture extends through the base of the thumb, the so called Bennett's fracture. The distal fragment tends to be thrown upward and backward. There is usually posterior and outward bowing.

There is acute wincing tenderness in the anatomical snuffbox. It is imperative to make a prompt diagnosis as failure to do so may result in marked disability of the thumb. Treatment of fracture of the base of the first metacarpal consists in reduction under general anesthesia. Reduction is accomplished by traction and hyper-



Fig 20 Treatment of Bennett's fracture. Cast and soft tissue traction with thumb in abduction

abduction. The position of the fragments is maintained by a plaster-of-Paris cast including the wrist and thumb. The position of the thumb is held in hyperabduction. The fracture is immobilized for 3 weeks at the end of which time the thumb may be held in abduction by adhesive plaster. The adhesive plaster should not be removed for an additional 2 weeks (Figs 19 and 20).

CONCLUSION

Kanavel has stressed the anatomy of the hand with regard to the treatment of infections. The anatomy of the hand should also be stressed in the treatment of fractures of the phalanges and metacarpals.

The treatment of fractures of bones of the hand has not received the proper emphasis. There should be at future meetings of national, state, and county societies practical demonstrations of the treatment of fractures of bones of the hand similar to those on the subject of fractures of long bone.

The proper supervision of the treatment of fractures of the bones of the hand is a responsibility of the chief of the fracture service.

An assistant surgeon, experienced in the treatment of fractures, should direct such treatment in the out patient dispensary.

NOTE—Figs 11, 12, and 13—courtesy of Dr. Paul A. Bishop, X-ray Department, Pennsylvania Hospital, Philadelphia.

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Fig 16 Soft tissue traction for fracture of metacarpal

skeleton. Attempting to elicit crepitus may disturb the position of the fragments—disturb a favorable position of the fragments—and render the treatment far more difficult.

A compound fracture of the middle phalanx associated with devitalization of soft tissues may require debridement and soft tissue or skeletal traction. Traction is also employed in the treatment of interarticular fracture, the line of fracture extending either into the joint between the midphalanx and distal phalanx or between the midphalanx and proximal phalanx (Fig 8).

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balance of muscle pull which may result in malalignment of the finger (Fig 10).

Pathological fractures of phalanges are not frequent. Such fractures may complicate osteomyelitis, bone cysts or other pathological lesions of bone (Figs 11, 12 and 13).

Fractures of the metacarpals are either transverse or oblique. The transverse fracture occurs at the distal end of the metacarpal bone just proximal to the head. This injury is usually caused by a blow with the fist. Unless the existing deformity is corrected obliteration of the knuckle may ensue. The fracture should be reduced under anesthesia. A straight dorsal splint may suffice but if the deformity tends to recur traction is imperative. This type of fracture, as well as the transverse or oblique fracture through the middle of the metacarpal may be erroneously treated by flexion of the hand over a roller bandage a position which aggravates the existing deformity (Figs 14 and 15).

If the fragments of a fracture of one or more of the 4 inner metacarpals cannot be retained by a posterior splint traction on the phalanges may be employed. Soft tissue traction is adequate in the majority of cases. Traction may be applied by one of 4 methods: lateral and circular strips of adhesive plaster; a narrow bandage or tape fastened to the finger with Sinclair's glue or paste, silkworm gut or wire passed through the nail or skeletal traction applied by means of a Mock finger caliper or stainless steel pin.

In the application of soft tissue traction the distal phalanx must be protected otherwise excessive pressure over the finger nail causes pain or may cause sloughing of the soft tissues.

There are many types of splints on the market for the application of skeletal traction. Most of these splints are cumbersome and expensive. An adequate fixation splint may be made with plaster of Paris incorporating the forearm (Figs 16, 17 and 18).

Fractures of the first metacarpal involve either

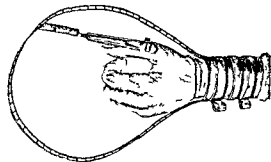


Fig 17 Metzler apparatus for skeletal traction

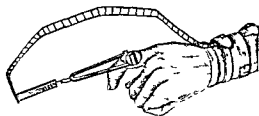


Fig 18 Metzler apparatus for skeletal traction

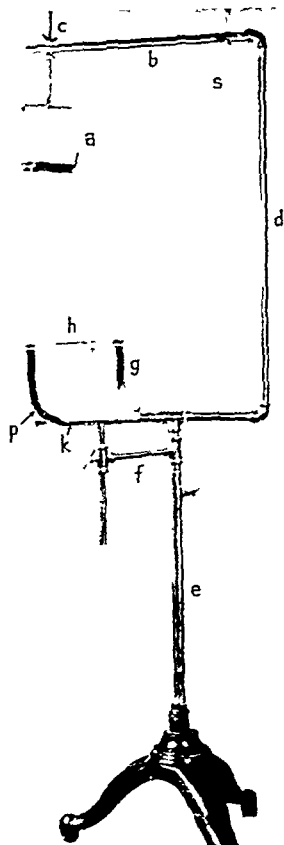


Fig 1



Fig 2



Fig 3.

Fig 1 Forearm stand *a* Finger grasp, position of rotation controlled by bar, *c*, *a* and *c* are detachable through split at end of pipe, *b*, which is removable from *d* and cross arm *s* for sterilization. Counter pressure elongated tongue *h* extends to elbow and is detachable from horseshoe *g*. Horseshoe on sleeve *p* is detachable for sterilization *k*. Arm pad, regulated at *f*, stabilizes the arm and prevents arm from crawling under *h* when traction is applied.

Fig 2 Patient sitting or lying on table, forearm in controlled position.

Fig 3 Sugar tong plaster is applied (felt on condyles) direct to skin to fix elbow.

tion in the restoration of position. In the upper forearm the ulna has a greater functional value and should, therefore, be accorded more consideration in reduction. In the middle of the forearm the bones are of equal importance. In oblique or comminuted fractures, slight overlapping may even allow a greater surface contact. The traction necessary to restore alignment will usually be adequate for apposition. The fragments in transverse and slightly oblique fractures may become separated by muscle planes and defy reduction by the usual methods. In such cases one bone can usually be gotten into position and the other may be improved by inserting a small lever or pry pin as designed by Thomson. Overlapping of the radius in the lower third, even with good position in the ulna, is not acceptable for transverse fractures. A contact of $\frac{1}{3}$ to $\frac{1}{2}$ under the same conditions is preferable to open reduction. In the author's experience with this type, approximately 10 per cent have required open

reduction. Including the middle and upper end of the forearm, 15 per cent have been operated upon. These figures applied to early cases of our own, and the decision to open was based upon our failure to get a good contact in the major fracture. Also, it was done in the knowledge that a technique used for fastening the fragments in accurate compression is simple in execution and almost certain for union. Fragments held in accurate contact with compression will not unite as rapidly as the same position by closed methods, however, union is much more rapid than a fracture in fair to poor position treated by closed method.

REQUIREMENTS OF GOOD SPLINTING

After the fracture has been reduced to an acceptable degree, provision must be made that splints can be applied without shifting or moving the forearm and allowing displacement of fragments. The elbow and the wrist should be immobilized and the metacarpophalangeal joints

FRACTURES OF BOTH BONES OF THE FOREARM EXCLUDING THOSE AT THE ELBOW JOINT AND WRIST JOINT

W B CARRELL M.D., F.A.C.S. Dallas Texas

FRACTURES of both bones in the forearm result usually from direct violence and may occur at any level between the elbow and wrist. Those in the upper half of the forearm covered by heavy muscular structures are more difficult to reduce, but fortunately will unite with good function even though reduction is not good. Those in the lower third require a more accurate contact for assurance of union, but here reduction is more easily accomplished.

Much of the deformity present is due to the initial trauma, but after the break there is faulty muscular balance producing rotation, deviation, and shortening. It is confusing to attempt in each fracture a complete analysis of the various muscles affecting the position, because with one notable exception manipulation and traction without regard to them will overcome their harmful influence. The exception relates to the rotation deformity caused by unopposed pull of the pronator teres when the radius is broken at a certain location. A working formula is that a position of supination should be imposed if the radial fracture is above the pronator teres insertion. In all other locations midpronation is desirable. Complete pronation is never indicated. Rotation to the desired position should be done before coaptating the fragments; otherwise the rotation is not under control.

Complications of nerve and circulatory damage are not as frequent as in some other regions of the upper extremity, but every case should be examined specifically for this before treatment is started. Roentgenograms are routinely made in two planes. Most fractures of both bones in the forearm except in small children can be properly prepared for reduction by means of local anesthesia injected directly between the fragments.

The usual method of treatment for fractures so easily palpated as are both bones of the forearm should on the whole give reasonably good results, but observation in the author's experience does not warrant this a supposition.

In the study of 100 cases of unsatisfactory progress in fractures of both bones of the forearm some interesting conclusions are reached. These cases were private patients either treated primarily in our clinic, or sent in from 2 weeks to several months after the injury because the progress was not satisfactory. In the analysis of this group it was found that approximately 40 per cent had not been well reduced. The bones were not in good alignment, or the contact was so poor that a satisfactory result could not be expected. In 30 per cent the original reduction had seemed fair, but the splinting was inadequate to maintain reduction and a resulting angulation or displacement had occurred. In 20 per cent there had been good reduction followed by good splinting, but the splints had been removed too early, with a secondary angulation and in some instances non union. In 10 per cent there were fractures with extensive trauma, extreme comminution, etc., and a poor result was inevitable. The obvious questions which arise from these statistics are (1) what constitutes a satisfactory reduction? (2) what type of splinting is best suited to maintain a good reduction? (3) how long should the splints be worn?

ESSENTIALS IN A SATISFACTORY REDUCTION

By manipulation and traction, one should get an acceptable position in 70 per cent of cases; 10 to 15 per cent will require open reduction. Alignment in longitudinal direction and rotation should be restored completely or with only a few degrees of fault, whether the fracture is in the upper, middle or lower third. Apposition cannot be accurately obtained in all cases although it is desirable and influences greatly the early consolidation of the fracture. The requirement for securing better contact in repeated manipulations or open reduction may outweigh in harmful influences the slow union incident to poor apposition. It is therefore a matter of judgment to make the final decision between acceptable and unacceptable positions. It is of some consequence that in the lower third the radius has a greater functional value and should receive more atten-

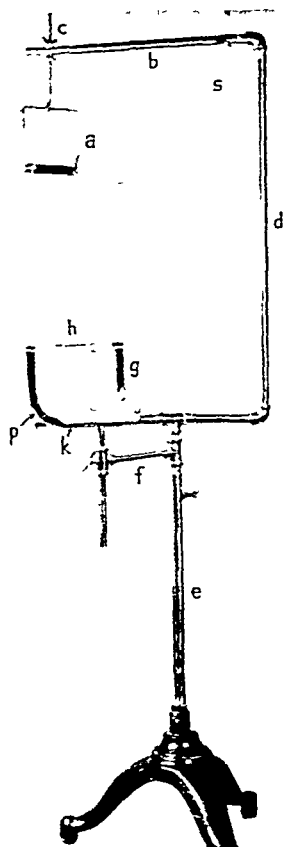


Fig 1



Fig 2



Fig 3

Fig 1 Forearm stand a Finger grasp position of rotation controlled by bar, c, a and c are detachable through split at end of pipe, b, which is removable from d and cross arm s for sterilization. Counter pressure elongated tongue h extends to elbow and is detachable from horseshoe g Horseshoe on sleeve p is detachable for sterilization k Arm pad, regulated at f stabilizes the arm and prevents arm from crawling under h when traction is applied.

Fig 2 Patient sitting or lying on table, forearm in controlled position.

Fig 3 Sugar tong plaster is applied (felt on condyles) direct to skin to fix elbow

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REQUIREMENTS OF GOOD SPLINTING

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Fig 4

Fig 4 a The plaster slab has been placed on back of hand forearm and arm b the anterior felt pad is in place

Fig 5

Fig 5 Bandage has been applied

Fig 6

Fig 6 The anterior plaster slab c completes fixation

left perfectly free. Manufactured splints rarely fit with sufficient accuracy to hold the position. Wooden splints padded and slightly wider than the forearm are used by many, but are difficult to keep at good tension and in the observation of the author have not prevented deviation of the ulna in a posteromedial direction. Circular plasters have been used but should be condemned for general use because of the danger from swelling and circulatory damage. The application of plaster splints well applied, meets the requirement of good fixation with controlled tension and freedom from circulatory damage.

METHOD OF FIXATION

With the forearm held in a mechanical appliance as shown in Figure 1, which is original only in some features¹ a fixed position is maintained which is superior to the most careful holding by an assistant. Increased traction supination and

pronation to any degree, are under complete control. When the position has been accepted and confirmed by roentgenogram then the dressing is deliberately applied. The elbow which is at right angle is first fixed with a sugar tong splint. This extends to within 2 or 3 inches of the axilla, no padding is used on the arm except a felt over the condyles and olecranon. This sugar tong is bandaged smoothly to the arm. After placing a small felt over styloids, a broad slab of plaster, wet is applied to the back of the hand wrist and forearm and bending at the elbow extends up the back of the arm over the bandaged sugar tong splint which has just been applied. This wet plaster is molded smoothly to the posterior medial and lateral surfaces of the forearm. Before bandaging to the forearm a strip of soft, piano felt is placed on the palm anterior surface of the forearm and beyond the bend of the elbow. The wet plaster on the back of the forearm which has no padding is then bandaged over the padded anterior surface and the smooth approximation

¹ The principle is old and several firms manufacture it. Use of the principle of the apparatus described in this paper is not intended to be a criticism of any of the apparatuses now in use.



Fig 7 a

Fig 7 b

Fig 7 c.

Fig 7 H S a, Malunion with pronation and deformity, b, lower fragment rotated and fixed with screw, c, 2 months after operation

Fig 8 B E S Comminuted fragments usually approximate well with light traction, skeletal fixation is not required

is made Another plaster splint is now applied to the anterior surface, extending from just proximal to the metacarpophalangeal joint over the palm, anterior surface of forearm, and up the anterior surface of arm This plaster splint is wide enough slightly to overlap the posterior splint on the two sides It is bandaged in position Slight interosseous grooving of plaster with a small pipe, as suggested by Boehler, makes the fit more accurate When the plaster sets, the arm is released from the apparatus and the upper arm section smoothed off with additional bandage

INDICATIONS FOR EXTENSION

When both bones are badly comminuted some extension is necessary to maintain good alignment In oblique fractures it is sometimes necessary to maintain extension to prevent the fragments sliding off into deformity. In occasional cases with transverse fractures one is able to get what appears a fair contact in two views, and yet the reduction may be very unstable A slight extension is beneficial in this type Extension when advisable may be carried out either by weight and pulley methods, when the patient has



Fig 8



Fig 9 F C a Common type of fracture deformity b radius most important in this region fault in ulna will not interfere with function

the arm in bed traction, or it may be done in combination with plaster fixation method. The latter is more efficient. For moderate traction the method just described can be applied so accurately that some degree of traction is maintained without the aid of Kirschner wires. For more positive traction and especially indicated where in addition to the forearm fracture, there is a fracture in the humerus it is best to place a wire through the ulna about 2 inches distal to the olecranon and another either through the lower end of the radius and ulna or

through the medial three metacarpal bones. With the wires in place the plaster can be applied in the usual manner, incorporating the wires and thus maintaining a fixed traction when the plaster hardens. Before the plaster sets the patient is placed in bed with a spreader on the distal wire and suspension for the necessary traction. In the series of unsatisfactory results studied the author was impressed with the slow union which occurred in several patients treated by traction. It should be recognized that very little traction is needed in the forearm because even without wires



Fig 10 V V a Unstable transverse type of fracture b position secured by skeletal fixation

Fig 11 J V Good plating with traction badly comminuted Compound fractures permit more satisfactory reconstruction later

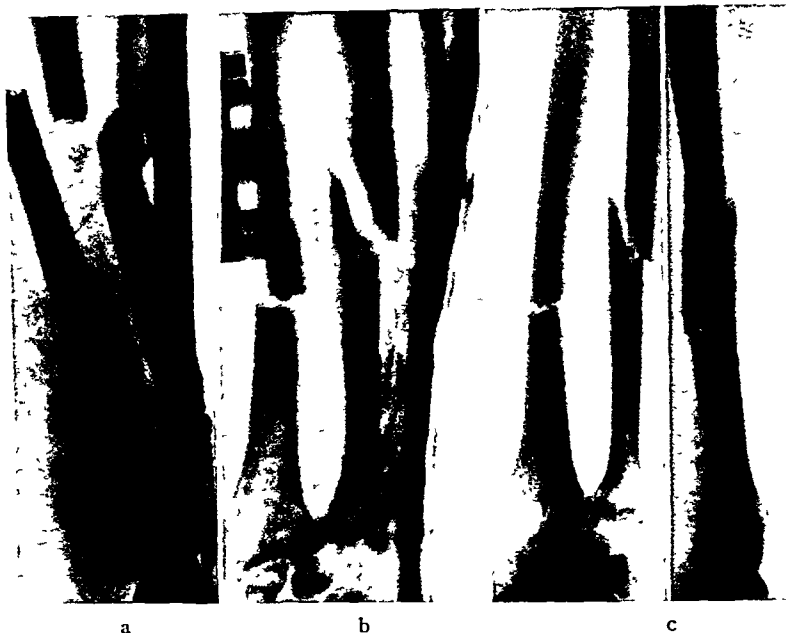


Fig 12 W E W a, Fracture with deformity, b distraction excessive by plaster fixation, c, same in delayed union 2 months after injury

the bones may be put up with too much distraction and consequently delayed union. Rarely should fixed traction be used except in fractures of the forearm, complicated by fracture in the humerus, or in compound fractures of the forearm which are badly comminuted and in which splintage must be disturbed for dressings

LENGTH OF TIME SPLINTS SHOULD BE WORN

Fractures about the middle and lower third of the forearm unite very slowly. Fixation should be maintained until the union is firm. In adults 60 to 90 days is the average period. Removal of splints when the callus is soft seems in our section of the country to be a common error. With early removal there is a gradual angulation, and remodeling at this late stage may endanger final union. Removal of the complete fixation and substitution of a light forearm splint is likewise hazardous. In the full fixation a patient is encouraged to use the shoulder, fingers, and thumb freely, carrying out daily every motion of these joints and working in so far as feasible with the handicap of splinting.

CONCLUSION

The author, through observation of many poor results, has learned that the common errors are

inadequate reduction, imperfect fixation, and removal of splints too early. These errors account for approximately 90 per cent of poor results. With careful reduction accomplished by manipulation combined with traction, a satisfactory alignment should be secured in all cases. A fair reduction should be had in the preferable bone, depending upon its location, and an acceptable position in the other. If this position is maintained by a controlled mechanical appliance as simple as the one illustrated, then proper plaster splinting can be fitted to the forearm in such a manner that it will hold the fragments as they have been reduced and will not compress the forearm unduly. Very few fractures need any supplementary traction, either fixed in the plaster through pins or otherwise. Open reduction should be very seldom required, but with definite indications should be done. The apparatus described is so constructed that it is an ideal sterilizable unit for maintaining position in operations on the forearm. Fifteen per cent of early cases have required open reduction but the percentage is apparently decreasing with better closed methods. There will always be a necessity for open reduction in planning treatment 2 or 3 weeks after the injury, when the fragments are frozen in deformity.

SYMPOSIUM ON CANCER

CORRELATION OF BODY SEGMENTAL TEMPERATURE AND ITS RELATION TO THE LOCATION OF CARCINOMATOUS METASTASIS

Clinical Observations and Response to Methods of Refrigeration

TEMPLE FAY, B S M D, F A C S and GEORGE C HENNY M S, M D,
Philadelphia Pennsylvania

IN 1932 our clinic¹ was engaged in the study of body temperatures from the standpoint of neurological segments or dermatomes (Fig 1) The purpose was primarily to ascertain if tumors or lesions of the spinal cord produced characteristic changes of surface temperatures in the dermatomes at or below the level of the lesion

Irritation, heat, and pain produce hyperemia in the segmental area of stimulation. Conversely, cold produces vasoconstriction and ischemia, in the same neurological reflex arc (Fig 2)

Much time was devoted to the perfection of a thermocouple and galvanometer that would be sufficiently sensitive to give accurate readings to within 0.36 degrees Fahrenheit (0.2 degrees Centigrade). Studies² on normal patients revealed that when the body area was divided into its neurological dermatomes according to nerve roots and segments of the spinal cord, the segments overlying the breast area (fourth and fifth thoracic) in both male and female showed consistently higher temperatures than the adjacent segments above or below.

On the other hand, as might be expected the segments supplying the extremities (sixth cervical to second thoracic and second lumbar to first sacral) fell far below other areas of the body under usual environmental temperatures. With the exception of the breast segments the areas of the trunk maintained a fairly uniform level. The head and neck showed con-

sistently higher temperatures than the rest of the body. The average normal, surface body temperature was found to be 63 degrees Fahrenheit (3.5 degrees Centigrade) lower than that of the mouth. The temperature of the distal portion of the extremities, however, fell from 12 degrees Fahrenheit (6.7 degrees Centigrade) to 20 degrees Fahrenheit (11.1 degrees Centigrade) below the normal mouth readings in certain instances and from 0.18 degrees Fahrenheit (0.1 degrees Centigrade) to 8.3 degrees Fahrenheit (4.6 degrees Centigrade) in the male normal control group (Fig 3).

TEMPERATURE AND GROWTH

It is universally recognized that temperature has a direct influence on growth in all forms of cellular life and that in seeds and eggs particularly a certain range of 'critical temperature' is required to activate the normally fertilized single cell.

One of us (Fay) began a close investigation into this factor as it might apply to the problem of abnormal cell growth and activity in the human body.

When the body segmental areas were divided into the high and low temperature fields a striking correlation appeared to exist between the location of rapidly growing types of metastatic malignancy and the segmental areas of relatively high surface temperatures. The locations favoring metastatic growth fell almost entirely within the segmental areas of highest body temperature whereas it was extremely rare to find records of such lesions in the distal portions of the extremities where the segmental temperatures are lowest even though metastatic tumors were shown to be widespread and, in certain instances undoubtedly blood borne.

From the Temple University Unit of the International Cancer Research Foundation.

Presented in the Symposium on Cancer before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1951.

¹Department of Neurosurgery.

²Fay Temple and Henny C C. Thermocouple studies on segmental surface areas of the body. (In press)

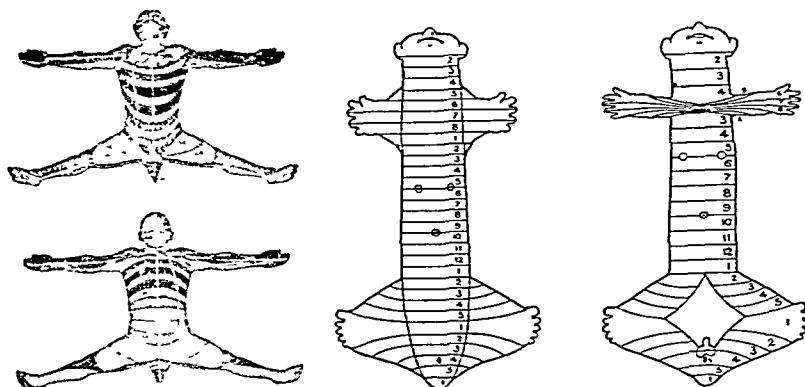
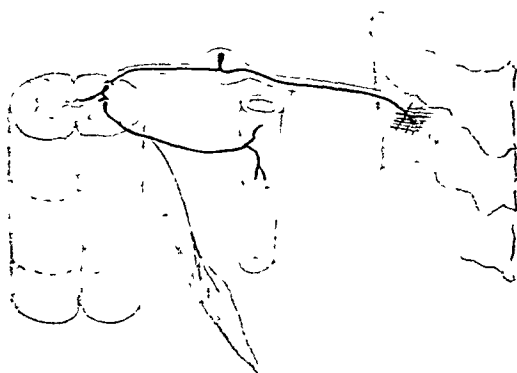


Fig 1 The human segmental dermatome pattern as it arises and ultimately becomes differentiated. In order to appreciate the definite relationship and sequence of these segments, the human being must be placed in a position similar to that assumed by the alligator, with thumbs and toes pointing upward and with the oral and anal openings of the gut tube representing the two extremes of segmentation of the organism. (Courtesy William Wood & Co From Purves-Stewart)

Recognizing this factor to be only one among a host of other equally important considerations, a search of the literature was made to determine what information was available on this point.

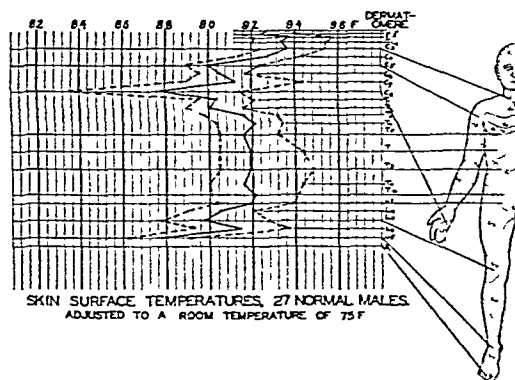
It was disappointing to find no reference in the literature as to the influence of diminished and

subnormal temperatures upon malignant cell growth. Although much has been done in the field of hyperthermia, clinical and pathological studies on tissue response to the principle of "refrigeration" are conspicuous by their absence. Examples of arresting growth and preserving food stuffs, through sustained measures of induced low temperatures, are so common in our agricultural,



SEGMENTATION OF CORD SEGMENTATION OF VASCULAR TREE SEGMENTATION OF SKIN

Fig 2 Segmental pain and temperature arc representing local cord responses to the principles of irritation and counterirritation produced by *pain* and the *extremes of heat and cold*. This neurological arc is the most primitive unit of the sensory system and still retains its original segmental plan for dermatomes of the skin, segmentation of the tubes, and branches of the vascular system as well as the visceral gut tube and its many visceral organ proliferations. Hyperemic and ischemic responses follow the segmental influences arising in the various components of the reflex arc.



SKIN SURFACE TEMPERATURES, 27 NORMAL MALES
ADJUSTED TO A ROOM TEMPERATURE OF 75 F

Fig 3 Composite graph indicating various segmental temperatures in 27 normal males. The range of variation in the group is denoted by the broken line—the average for the group by the solid line. Note the definite peak of temperature curve in the fourth thoracic segment supplying the breast, even in the male. In the female the curve is higher and more variable depending upon the age of the patient and the sexual function of the gland. Favorable sites for metastatic malignancy lie near or above the base body line. Segmental temperatures in the extremities are obviously lower with the exception of the area of the knees. These areas appear to be "unfavorable" for the location of metastatic carcinomatous cell growth.

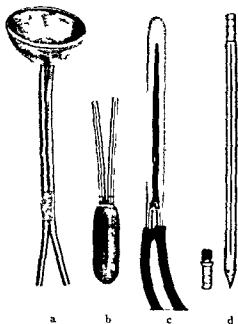


Fig 4. Hollow instruments devised for application to the area of tumor involvement. Solutions at various regulated temperature levels may circulate within the hollow instrument and thus influence the local temperature of the part adjacent to its surface. a Vaginal cup designed for application about the cervix. b Vaginal bomb designed for insertion into the eroded cavity produced by the tumor. c Hollow knife blade designed for application beneath surface lesions such as the breast or for deep implantation into lesions of the soft tissues and the brain. d Hollow pin designed for introduction into deep tumor masses involving the long bones and accessible surfaces where the instrument can be inserted through the growth itself permitting return of circulation directly through the opposite side of the part involved. (Note—The sharp metal point is removable and fitted to a nipple capable of accommodating the rubber tube used to return solution. Various lengths and shapes of instrument may be required.)

industrial and economic life that they need no mention. The ice box or refrigerator serves this purpose in every home. The fact that the fertilized hen's egg lies dormant as a single cell until activated *alone* by the influence of a critical temperature around 103 degrees Fahrenheit (39.4 degrees Centigrade) is worthy of far deeper consideration than would appear at first glance. The knowledge that we may prevent this event by cold storage, or determine its initiation by controlled means of incubation places temperature as the prime factor of consideration.

The striking fact remains that temperature *alone* is required to bring into existence activation of the rapid embryological cellular division



Fig 5. Coil devised for refrigeration of accessible areas of cranial metastasis.

that in the instance of the egg, follows normally differentiated patterns if allowed to perist.

Certain important factors concerned with plant and agricultural growth, aside from the great seasonal influence of temperatures are worthy of consideration in the hope that they may shed further light on the means of dealing with human cell response.

Given intense sunlight and sustained low temperatures, adaptable plants (moisture and proper nourishment being considered adequate) tend to come slowly to a stunted maturity (viz. mountain vegetation above the so-called 'timber line'). Conversely, darkness and sustained abnormally high temperatures give rise to overgrowth and delayed maturity (viz. plants or tubers in a warm cellar). When sunlight is combined with optimal temperatures (moisture and nourishment being adequate) the combined effect favors both growth and maturity (viz. tropical or hothouse vegetation).

Again a suggestive analogy appears in the clinical history of certain types of malignancy. The slower growing, more mature forms of squamous carcinoma of the exposed hands where temperature is lowest and sunlight exposure greatest are in distinct contrast to the more rapid activity of squamous carcinoma of the cervix where a temperature of from 1 to 3 degrees Fahrenheit above the mouth normal exists, and a complete absence of light prevails.

SCOPE OF INVESTIGATION

The purpose of this presentation is to submit a preliminary report on the steps which have been



Fig 6 Case 1 K. L. Squamous carcinoma cervix grade IV with massive pelvic extension. Original cooling apparatus devised to maintain constant temperature 50 degrees Fahrenheit in the vaginal bomb. Water reservoir allows constant flow of fluid through ice coil and regulation of flow adjusted to give temperature 50 degrees Fahrenheit to fluid returning from the vaginal bomb. Relief of pain and general improvement of physical state followed 5 weeks of constant irrigation.

taken to establish whether in approaching the problem from this new point of view, the factors aforementioned are merely a coincidence, or whether there may exist, as elsewhere, a significant correlation between critical temperatures and growth.

With the encouragement of Dr. James Ewing and the assistance of a grant from the International Cancer Research Foundation, Donner Fund, the following lines of investigation have been undertaken:

1. Thermocouple readings of body surface segments and visceral organs have been taken to establish a normal controlled group to serve as the base line for comparison with the pathological material under study.

2. Thermocouple and temperature studies in the region of malignant tumor masses have been carried out. Where these areas of cellular activity were accessible, apparatus has been devised to modify the local temperature in and about the area of the lesion, over extended periods of time.

3. Comparative biopsy studies of tissue of malignant growth, before and after treatment by methods of refrigeration, have been undertaken under the direction of Dr. Lawrence Smith, professor of pathology.

4. Clinical response of the patient to factors concerned with pain, weight, rapidity of progress of malignant mass, and evidence of metastatic activity have been noted, before, during, and after treatment designed to lower local temperature.

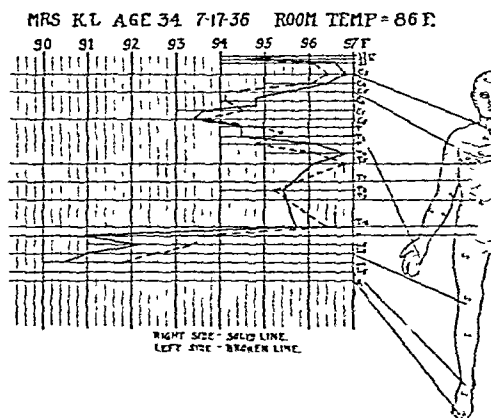


Fig 7 Case 1 K. L. Skin temperature chart showing prominence of surface temperatures in the dermatomeres concerned with the breast segments as well as definite and marked rise in the twelfth thoracic segment in the visceral pelvic zone. Carcinoma of the cervix with pelvic extension.

5. Studies are now under way to determine whether certain temperatures may not be "critical" in the development of the normal cell activity (e.g., fertilized eggs and seeds) with observations directed toward the influence of "subcritical" temperatures and refrigeration on maturity and rapidity of growth.

6. Tissue culture of the normal and pathological human tissue is now being carried out under the direction of Dr. Lawrence Smith by Miss Lillian Sherman, according to George and Margaret Gey's technique.

7. Response of normal and pathological tissue cultures to "critical" and "subcritical" temperatures has been noted.

8. Comparison of biopsy material, *in vivo* and *in vitro*, in which controlled temperature in the patient is duplicated in the tissue culture test-tube and comparative periodic biopsy and tissue studies are being undertaken.

CLINICAL STUDIES

The following patients were considered hopeless cases of extensive metastatic carcinoma and were referred to our care only after all other available means had been considered either unavailing or useless. Quite naturally, we have not accepted for this series any case in which an orthodox method of treatment is indicated.

CASE REPORTS

CASE 1. K. L. No. N. S. 1959, Temple University Hospital, white female, aged 34. Diagnosis: Carcinoma of the cervix with pelvic extension.



Fig 8



Fig 9

MRS M V AGE 36 12 24 36 ROOM TEMP 70.1 F
69 90 81 92 93 84 95 96 97 F

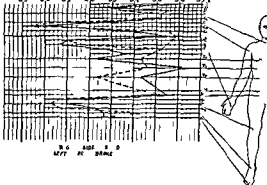


Fig 10

Fig 8 Case 2 M V Photograph taken 9 months after treatment October 19 1937 Residual kyphosis of cervical mid-dorsal area Patient pursuing housework at the present time and apparently symptom free except for visual impairment

Fig 9 Case 2 M V Nine months following treatment (October 19 1937) Note atrophy and position of the left side of the face secondary to the large cervical compression lesion involving the vertebral bodies Paralysis disappeared and roentgenographic evidence of healing was noted within 3 months there was noted also disappearance of the malignant cells from the optic disc with partial return of vision

MRS M V AGE 36 3 22 37 ROOM TEMP 73.4 F
86 87 88 89 90 91 92 93 94 F

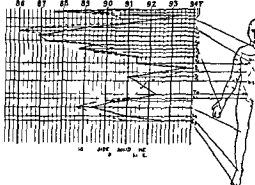


Fig 11

Fig 10 Case 2 M V Temperature chart upon admission showing irregular peaks of temperature. The points at eighth cervical and seventh thoracic zone of deep metastatic involvement of the cord and its roots at these levels General base line approximately 94 degrees

Fig 11 Skin temperature readings 4 months following radiation of the pituitary thyroid and ovarian glands undertaken to produce a state of hibernation Notice the more uniform character of skin temperature responses with peak of the curve persisting in the region of the large dorsal metastatic mass but approximating normal in other areas. Base line has shifted to approximately 91.5 degrees. The fall of basal metabolic rate at this time indicated that the principles of hibernation had been successfully induced

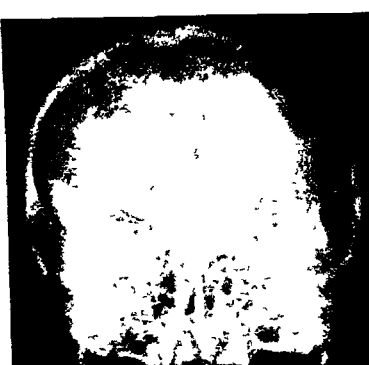


Fig 12a



Fig 12b

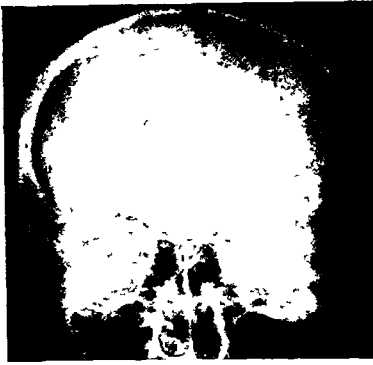


Fig. 12c.



Fig 13a



Fig 13b



Fig 13c

Fig 12 Case 2 M V a, Metastatic carcinomatous erosion of the skull December 21, 1936 b, Healing and improvement noted in films taken March 23, 1937, following radiation of pituitary, thyroid, and ovaries with inducement of "hibernation" c, Roentgenogram of the skull made 9 months following treatment shows almost complete re-

generation of bone—this film was taken September 23, 1937

Fig 13 Case 2 M V Roentgenogram of the pelvis showing multiple metastasis to the bones Note the ramus of the pubis with roentgenographic evidence of healing a, Roentgenogram taken December 21, 1936, b, March 23, 1937 c, September 23, 1937

Patient had been treated on the gynecological service (Dr Hammond) and out patient department since February 15, 1936, receiving radium implantation (5600 mgm. hours) and deep x-ray therapy (5400 roentgens to each front and back of pelvis) Severe pain in the back ensued with reference down the right lower extremity requiring relief Injection of absolute alcohol was made into the lumbar sac (Dr Scott), with relief of pain for 2 weeks

Patient was admitted to the neurosurgical service July 7, 1936, for operative relief of pain (chordotomy) Diagnosis inoperable carcinoma of the pelvis with rectovaginal fistula, nodular involvement of the cervix, induration of the deep pelvic tissue

Excepting for emaciation and obvious extension of carcinoma into the pelvis, Wassermann and other clinical findings were essentially negative X-ray examination of the skeleton and lungs revealed no metastasis Biopsy disclosed squamous cell carcinoma It was decided to attempt local refrigeration and to observe the response Refrigeration unit with vaginal "bomb" (Fig 4b) was constructed and irrigation of solution at temperature of 60 degrees F (15.5 degrees C) was begun July 21, 1936 Thermocouple readings of cervix (July 30, 1936) showed temperature of 77 degrees F (25 degrees C) 5 minutes after removal of vaginal bomb (22 degrees F 15.2 degrees C below mouth temperature) Continuous irrigations maintained Patient required 1/2 grain morphine sulphate every 4 hours prior to refrigeration On third day following

cold irrigations, pain was relieved and morphine was withdrawn Three weeks later, marked improvement was noted by gain in weight, freedom from pain Pelvic examination (Dr Burnett) 1 month after refrigeration revealed that the rectovaginal fistula was partially healed the congestion and induration about cervix and vaginal mass were markedly decreased Patient was discharged September 2, 1936 and returned home where she cared for her children, undertook housework, and was symptom-free for 2 months

She was readmitted, December 31, 1936, with return of pain, requiring narcotics (given by local physician). Examination revealed induration of the broad ligament, rectovaginal fistula greatly increased in size; extension of the malignancy to deeper pelvic structures X-ray examination was negative for bone and lung metastasis A high thoracic chordotomy was performed, January 25, 1937, with destruction of the pain fibers below the umbilicus, resulting in complete relief of pain Reapplication of refrigeration method, 50 degrees F (10 degrees C), February 18, 1937, produced local improvement in gross tissue about the area of application Her general physical condition improved for 3 weeks Extension of the deep portions of the lesion Death was the result of urinary infection and pulmonary infarction with bronchopneumonia, April 8, 1937.

Summary of pathological and autopsy findings Squamous carcinoma of uterus and cervix (grade IV) with extension to bladder, rectum fifth lumbar vertebra, and sacrum Pulmonary embolic infarction and gangrene right lower



Fig 14 Case 3 R W Carcinoma simplex of the breast grade III following extensive radiation. Diffuse metastases to lung liver scalp brain left femur right eighth and ninth ribs. Figure shows application of hollow refrigeration blade inserted from the midline to a point beneath the primary tumor mass. Tube connections for continuous cold irrigation and thermostatic temperature control mechanism seen in the background. Note effects of previous deep radiation to axillary region.

lobe. Rectovaginal vesical fistula—pyelophrenitis chronic cystitis. Carcinomatous thrombosis of right iliac and femoral veins.

Relief of pain following local refrigeration to the area was an outstanding factor. Improvement in the patient's general physical state with gain of weight was noteworthy. Gross reduction in the bulk of the lesion with tendency toward temporary healing of the rectovaginal fistula was grossly evident. The patient prior to treatment, was bedfast and appeared to be in the terminal stages of her malignancy. Two months of a symptom free state followed the local refrigeration. The patient lived 9 months from the onset of refrigeration treatment.

The benefit of the early deep radiation cannot be overlooked even though the generalized improvement appeared to follow promptly the onset of refrigeration.

CASE 2 M V No N S 3112 Temple University Hospital. White female aged 36 years. Diagnosis carcinoma of the left breast with metastasis to spine skull pelvis ribs and humerus.

Patient was admitted to the neurosurgical service December 20 1936 referred by Dr John Frick. Onset occurred January 1936 with pain between shoulders and in neck and weakness of upper extremities. She became progressively worse and was bedfast on admission. Four weeks prior to admission she developed diplopia with failing vision and pain behind right eye. There were signs of spinal cord compression with weakness of lower extremities.

Examination revealed marked deformity of the cervical spine with occiput almost approximating spine of seventh

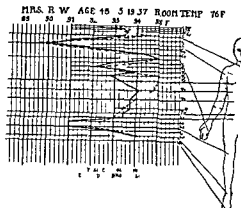


Fig 15 Case 3 R W Segmental dermatome chart indicating surface temperatures with marked and definite rise in segments involving the left breast. Note that the response is unilateral to the area of primary tumor involvement.

cervical vertebra. Movements of head were limited to about 15 degrees and pain felt when turning to right. A marked kyphosis was noted in mid-dorsal area. An irregular mass was noted in left breast lower half about 5 centimeters in diameter and fixed to the skin. Large lymph nodes were noted in left axilla and supraclavicular areas. Heart and lungs were negative. No abdominal masses present. Pupils were dilated and fixed. Vision for light and moving objects only. Bilateral sixth nerve palsy. Choking of optic disc 5 diopters with infiltration of nerve heads with malignancy (Dr Lillie). Fingers hands and forearms were very weak more on the left. Triceps reflexes were absent. Marked atrophy and impairment of motor power were noted in all extremities slight left ulna anesthesia. X-ray examination at this time revealed metastasis of the spine ribs skull and pelvis and coniform deformity of a number of vertebral segments.

Extensive involvement precluded local refrigeration treatment to individual areas. It was decided to attempt to reduce the entire body temperature by radiation of the pituitary thyroid and ovarian glands in the hope of inducing a state of physiological hibernation (basal metabolic rate +18 per cent). The following deep x-ray therapy was administered: 200 r to each temporal area 400 r to thyroid pelvis 1600 r to each front and back in addition the cervical spine was given 1600 r on each side and left eye 1600 r (as control). Other lesions were not radiated. Patient was discharged January 12 1937 improved.

A recheck on skeletal system by x-ray March 22 1937 revealed marked improvement compared with the previous examination December 24 1936. The basal metabolic rate on this date was -6 per cent.

Readmission to neurosurgical service for study September 22 1937. Patient was symptom free except for poor vision residual claw like deformity of left hand and the cervical and dorsal spine deformity. The tumor in left breast is about 1/2 former size. Vision is improved (secondary optic atrophy). No other cranial nerve involvement. X-ray examination shows marked degree of new bone formation at sites previously showing bone destruction. Basal metabolic rate -11 per cent. Patient is well and asisting in housework. (Patient continues well 13 months following treatment January 1938).



Fig 16 Case 4 T D Metastatic carcinoma (hypernephroma) involving both knees Left knee received deep radiation treatment. Right knee continued local refrigeration Generalized metastases to brain, scalp, chest, lung, and skeletal areas Rapid diminution in size of the lesion following refrigeration

Although the response in this instance has been dramatic and the patient's sight has returned sufficiently to carry on routine household duties, nevertheless, similar improvements have been noted in cases of widespread metastatic carcinoma of the breast following deep radiation of the ovaries alone

Is it possible that the disturbance in the hormonal influences recognized between the ovaries and the breast involves the question of hyperemia and consequently entails a temperature incidence which has formerly been overlooked?

In this instance, at least, body surface temperature was shown to be markedly reduced 3

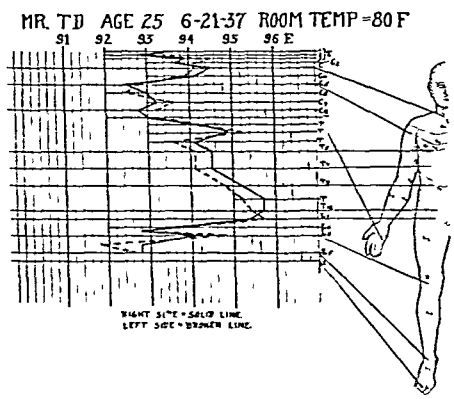


Fig 17 Case 4 T D Skin temperature chart showing distinct rise in segmental temperatures concerning the knees, more marked on the left than the right Metastatic lesions larger and more active on the left

months following radiation, and there was as well a fall in the basal metabolic rate. A return toward the normal segmental surface temperature pattern was noted 9 months following radiation, although the basal metabolic rate showed further reduction

The prompt disappearance of the malignant cells seen in the eye grounds afforded an opportunity to observe the cellular response under the ophthalmoscope. The left eye was treated with deep x-ray therapy, but the right eye was permitted to escape treatment in order that it could be observed as a control. The malignant cells disappeared simultaneously in both eye grounds, and there was evidence of healing processes in the areas of untreated bone, indicating the influence of some contributing factor aside from the direct influence of radiation upon the secondary lesions.

The response of untreated secondary lesions to ovarian radiation is well recognized. The close relationship between ovarian function and vasomotor responses concerned in the normal physiology of the breast and other organs is generally recognized So far as the authors can determine, thermal studies have not been made upon cases of primary breast carcinoma with metastasis to determine comparative temperatures before and after treatment of the ovaries As this is the only case so far recorded in which such comparative studies have been made, the observations must be considered as a coincidence until further material has been studied Attention is merely called to the fact that a deliberate attempt was made to reduce the general body temperature and

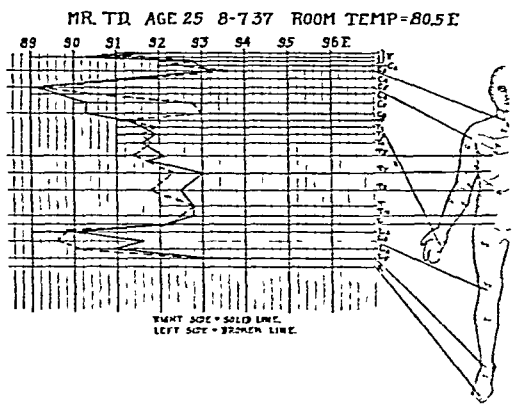


Fig 18 Case 4 T D Skin segmental temperature chart showing generalized fall in body temperature following radiation of pituitary, thyroid and gonads Note left knee area shows distinct fall in surface temperature which corresponds to distinct clinical improvement in the size and growth



Fig 19 Case 5 M T Irrigation unit with constant thermal control used for clinical observations of the effect of refrigeration on accessible carcinomatous areas Note vaginal bomb connected with irrigating system

the result obtained followed combined deep radiation therapy to the pituitary thyroid and ovarian glands in an attempt to produce a state of subnormal body temperature and metabolism approximating the phenomena of hibernation. Patient continued well and symptom free 9 months after treatment (See final note)

CASE 3 R W No V S 3320 Temple University Hospital White female aged 48 years Diagnosis carcinoma



Fig 21 India ink injection showing reticulo-endothelial system of the bone marrow in the rat Note newborn rat on the left maintains red bone marrow in the segments of the tail and small bones of the feet Illustration to the right indicates adult rat with retention of red bone marrow if the portion of the tail is buried in the abdominal cavity (portion distal to the ring) loss of red bone marrow in portion of the tail exposed to lower temperatures Note disappearance of red bone marrow in the distal portions of the extremities secondary to unfavorable thermal influences (From Huggins and Noonan)

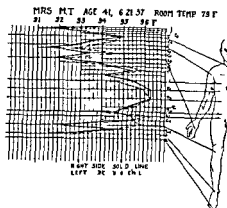


Fig 20 Case 5 M T Surface segmental temperature chart in case of carcinoma of the cervix with extension into the pelvis and visceral segments Note high point of curve correspond strikingly with the underlying visceral areas involved

of left breast with metastasis to skull ribs, left femur spine and pelvis

Patient was transferred to neurosurgical service from x ray and orthopedic departments May 16 1937 with diagnosis of carcinoma of left breast and pathological fracture of left femur Diagnosis of inoperable carcinoma had been made in the surgical diagnostic clinic October 26 1936 Between November 20 1936 and December 8 1936 15 treatments totalling 3 000 r were given over the left breast left axilla in addition 600 r each to anterior and posterior aspect of pelvis to produce artificial menopause February 10 1937 350 r to anterior and posterior aspect of left knee Metastases to pelvic bones and first lumbar vertebra were treated with 4 800 r over sacrum and lumbar spine The secondary lesions persisted and pathological fracture of left femur occurred in May 1937

Examination revealed a mass in the inferior lateral quadrant of left breast about 5 by 6 centimeters The tumor was hard and free to movement but adherent to overlying skin There were palpable lymph nodes in the left axilla The left chest was tender to pressure over fifth rib The remainder of examination was negative The left lower extremity was in a plaster cast There was a radiation scar of left axilla

A knife like hollow refrigeration blade (Fig 4c) was passed laterally from the midline beneath the growth (May 22 1937) for the purpose of local refrigeration The hollow knife blade was sutured to the skin surface and water was circulated with temperature regulated to 60 degrees Fahrenheit (15.5 degrees Centigrade) in the out flow Daily skin temperature readings over the four quadrants and nipple of each breast showed a temperature over the cooling blade consistently cooler 1.8 to 3.5 degrees Fahrenheit (1 to 2 degrees Centigrade) than the other parts of the same and opposite breast while previous to refrigeration the left breast was 1.8 degrees Fahrenheit (1 degree Centigrade) warmer than the right Diameter of tumor mass was 4.5 centimeters May 24 1937 and 4.3 centimeters May 27 1937 Three weeks after onset of refrigeration the entire breast tumor was removed for study The tumor was very firm and measured 2 1/2 to 3 centimeters Patient died June 17 1937 with metastasis to the lungs pleural effusion and pulmonary atelectasis

Summary of pathological findings—Autopsy Carcinoma of left breast medullary carcinoma simplex lungs meta

static carcinoma, bilateral diffuse atelectasis, left lower lobe with effusion; liver, metastatic carcinoma; head, metastatic carcinoma of bones of skull, femur, metastatic carcinoma with pathological fracture, metastatic carcinoma of ribs, spine and pelvic bones; pituitary, metastatic carcinoma

A late case of inoperable metastatic carcinoma was studied after radiation to the ovaries and areas of secondary involvement had been extensively carried out. Secondary lesions, however, persisted and gradually increased. The primary lesion to the left breast was grossly unchanged

The patient's condition was considered terminal and hopeless. Thermal studies were made upon the area of the primary growth. The left breast at all times maintained a segmental temperature higher than the corresponding area on the right.

A hollow blade was designed so that it could be inserted above the pectoral fascia and beneath the growth, permitting cold irrigation to be maintained continuously from beneath the tumor mass. The mass itself was not disturbed at the time of inserting the refrigerating blade and the instrument was maintained in the fascial plane beneath the growth, care being taken not to disturb local circulation to the part. The procedure was completed without bleeding, excepting for the local point of the skin incision near the midline

Gross measurements made of the tumor mass showed a reduction to approximately one-half of its former size, within a period of 5 days after the application of the cooling instrument.

Pathological studies of the tumor itself, by Dr. Lawrence Smith, revealed a cell necrosis similar to that noted in the normal tissues surrounding the point of entry of the refrigerating blade. There appeared to be a direct relationship between the advent of "refrigeration" and the tissue changes, both in the normal and in the pathological areas.

The case is noteworthy only in that surface temperatures demonstrated a response to local refrigeration. The size of the tumor mass diminished to a more firm and compact nodule, which probably can be ascribed to the ischemic effect produced by cold applications in the region of the tumor.

CASE 4. T. D., No. N. S. 3390, Temple University Hospital. White male, aged 24 years. Diagnosis hypernephroma—metastasis to pelvis, femur, knee joints, and lungs.

Patient was admitted June 14, 1937 to neurosurgical service for relief of pain. He was referred from x-ray and orthopedic departments with diagnosis of metastatic carcinoma of pelvic bones and distal end of both femurs. Biopsy was done December 12, 1936, from right ischium (carcinoma, renal? or prostatic? in origin).

Prior to admission June 14, 1937, he had been treated by radiation; 2,000 r. given to anterior right pelvis; 2,900 r. to posterior aspect of pelvis on right, and 3,200 r. to each anterior and posterior aspect of left knee.

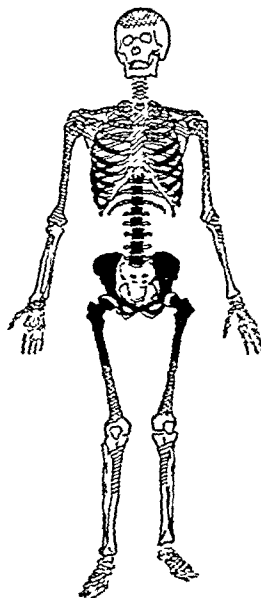


Fig. 22 Geschickter's chart¹ showing the most common sites for bone metastasis for carcinoma in the human (and sarcoma), according to skeletal localizations. Note striking similarity to Huggins' and Noonan's observations regarding the areas concerned with thermal influence upon growth and development of red bone marrow.

Examination revealed the following. The positive findings were marked emaciation; subcutaneous nodule in the scalp 1 centimeter in diameter; liver edge about 5 centimeters below right costal margin, diffuse tender indurated area in right buttock posterior to right hip and under scar of operation for biopsy. A large indurated swelling was present in the distal end of right thigh and knee which was hyperemic and tender. Movements of right knee limited.

Refrigeration to right knee was started June 25, 1937. The return flow of the circulating water was kept at 55 degrees Fahrenheit (12.7 degrees Centigrade). July 12, 1937, there was a very evident improvement in the right knee. The swelling and tenderness subsided. Pain was controlled in the area covered by the refrigeration apparatus but pain in hips and left lower extremity became so severe that opiates were given. A high dorsal bilateral chordotomy was performed (Dr. Scott) July 27, 1937. August 9, 1937, the circumference of right knee, 36 centimeters, left knee, 33 centimeters. The refrigeration apparatus was applied again and temperature of return flow of water was lowered to 45 degrees Fahrenheit (~2 degrees Centigrade). Biopsy from right tibia and scalp tumor on August 10, 1937, revealed metastatic carcinoma, adrenal in origin. August 16, 1937, circumference of right knee 34 centimeters, left knee, 31.5 centimeters. Patient died August 25, 1937, from urinary obstruction and infection.

Summary of pathological and autopsy findings: Lungs, metastatic tumor; adrenals, primary hypernephroma; left femur, pathological fracture, metastatic tumor, right knee, metastatic tumor. A small metastatic area was noted in the middle third of the right tibia. No other metastasis noted distal to elbows and knees.

¹Geschickter, Charles F., and Copeland, Murray. *Tumors of Bone*, 1936, p. 481. Published by Am. J. Cancer.

SUMMARY OF FIVE CASES

Case	No	Age Sex	Diagnosis and complaints	Metastatic locations	Treatment	Clinical observations	Result
1 (A)	NS 1959	K.L. F 34	Carcinoma of cer- vix. Bedfast. Intractable pain	Pelvic organs (rectovaginal vesicle fistula) gth lumbar verte- bra and sacrum. Right femoral and iliac veins	Radium 5600 mgm. hr X ray 5600 r each P and A. pel- vis. Refrigeration to cervix —6 wks	Symptom free 2 mos. Primary growth retarded. Fi- stula partially healed	Temporary relief. Re- turned to work 3 mos.
(B)	NS 1959	K.L. F 34	Readmission 3 mos later and return of pain	Same as above	Chordotomy and reft. gero- tomy—7 wks	Local improvement of growth	Lived 9 mos. Terminal pulmonary infection and broncho-pneu- monia
2	NS 1952	M.V. F 36	Carcinoma left breast. Bedfast. Weakness of up- per and lower extremities. Cord compression. Loss of sight	Skull spine pel- vis right hu- merus and optic discs	Hibernation induced by radi- ation—pituitary 4000 r. thy- roid 4000 r. and ovaries A. P. 12000 r. Left eye 18000 r. Cervical spine 18000 r each side	Symptom free except im- paired vision. BMR re- duced to $m + 12.5\%$ to -11.6%	2 w bone formation all destructive areas 12 mos. after treat- ment Jan., 1958, on evidence of metastatic bone tumors. X-ray shows former areas healed. Live grounds negative
3	NS 1950	R.W. F 48	Carcinoma of left breast. Patho- logical fracture left femur	Skull pituitary spine lungs spine pelvis and femur	X ray 3000 r. over primary growth. Refrigeration di- rect to primary growth—3 wks.	Primary gr. with rapidly be- came smaller and firmer. Removed after 3 wks re- frigeration 1 r study	Terminal in metastasis to lungs and pulmonary atelectasis
4	NS 1950	T.D. M 34	Hypertension Intractable pain	Knee joints scalp lungs pel- vis, femur right tibia	Deep x ray to all areas except right knee. Refrigeration 6 wks. Chordotomy	Local pain relieved. Marked reduction in size of right knee following 6 wks of refrigeration	Local relief. Died of renal obstruction and infection
5	NS 1950	M.T. F 41	Carcinoma of cer- vix. Intractable pain. Bedfast	Pelvic organs (rectovaginal vesicle fistula) Lungs	Radium 7200 mgm. hr X ray 5500 r each A. and P. pel- vis. Refrigeration to cervix —13 wks	Local improvement of pri- mary growth. P. ce. fr. m pain. Increase in weight	Terminal renal infection and uterine hemor- rhage

The generalized metastasis noted in this patient progressed in spite of full radiation. The rapid progress of the disease was characteristic of metastatic hypernephroma.

An opportunity was afforded to compare the results of deep x ray therapy to the left knee with refrigeration treatment to the right. The response to the radiation therapy on the left was definitely more pronounced than the response to surface cooling in the area of tumor on the right. Pain, however, was relieved in the right knee following refrigeration, whereas this symptom persisted in the left. Pathological studies by Dr. Smith revealed marked degeneration and necrosis of the cells of the tumor mass on the right with almost complete disappearance of the tumor excepting for a firm plaque within the capsule of the knee joint. The gross reduction in size of the tumor following refrigeration was measurable the circumference diminishing 2 centimeters in 10 days.

Surface temperature readings indicated a level in the involved knee joint approximating the surface temperature of the trunk and comparison between the two sides indicated that local refrigeration reduced surface temperature on the right 1.8 degrees Fahrenheit (1 degree Centigrade) below the left.

The case is of interest in view of the widespread metastasis of the scalp throughout the entire

body with the exception of the upper extremities and the areas below the knees. A small nodule was found deep within the right tibia.

A fall in general body surface temperatures was noted following radiation of the pituitary, thyroid and gonads (see Case 2).

CASE 5. M. T. No. NS 3369. Temple University Hospital. White female aged 41 years. Diagnosis: squamous carcinoma of cervix with pelvic extension.

The patient was admitted to the neurosurgical service on June 13, 1937, from the gynecological department for relief of pain. Diagnosis: inoperable carcinoma of cervix with rectovaginal fistula. Squamous carcinoma of cervix (grade III). Radium (1200 mgm. hours) had been given August 6, 1936. Between September 14, 1936, and January 24, 1937, total implantation of radium was 6000 mgm. hours. X-ray therapy over pelvis November 6, 1936, to January 8, 1937, five treatments of 500 r each were given over anterior and posterior aspects of pelvis.

The lower abdominal and back pain was not relieved by x-ray and radium therapy and at the time of admission to the neurosurgical service opiates were necessary to control pain.

The physical examination was essentially negative except the secondary anemia and pelvic findings. Biopsy of the cervix and pelvic examination were made by Dr. C. S. Miller June 15, 1937. The pelvis was completely filled by a large mass of tumor. A thick hard rim extended as a ridge along the left broad ligament. The normal structures could not be identified and a fistulous opening about 2 centimeters in diameter opened directly into rectum just posterior to the cervix. The biopsy from cervix was diagnosed squamous carcinoma of cervix grade III (Dr. Lawrence W. Smith).

Continuous refrigeration was started June 17, 1937, by applying a cooling bulb to the cervix. The circulating water through the bulb returned at a temperature of 60 degrees Fahrenheit (15.5 degrees Centigrade).

The pelvic pain was completely relieved when the cooling bulb was in apposition with the cervix and fistulous opening into rectum. Patient's general condition was improved. The cervix became hard and contracted. Spontaneous hemorrhage of uterus occurred September 10, 1937. There was marked pyelitis. Patient died September 12, 1937.

Summary of pathological and autopsy findings. Lungs, metastatic tumor of right lower lobe, abdominal retroperitoneal lymph nodes, metastasis from pelvic carcinoma; cervix uteri, malignant erosion—squamous carcinoma, grade IV.

In this instance, the gross results of treatment to the primary growth were not as striking as in Case 1, but the prompt and full relief of pain was a most gratifying sequence to the induced local refrigeration. The patient insisted upon maintaining the cold vaginal "bomb" and on several occasions when the apparatus required adjustment, was impatient for its reapplication. The tumor mass became firmer to palpation and the fistula became slightly contracted. Degeneration in the area of refrigeration was noted in the tissue at necropsy but the classification of malignancy from grade III to grade IV indicated actual increased activity of the cells, as determined by mitotic figures.

With the relief of pain, the patient's general condition improved sufficiently to occasion the desire of discharge from the hospital because of her subjective freedom from symptoms.

Pyelitis was a complication in this instance and a sudden spontaneous hemorrhage into the uterus, 2 days before death, was followed by subsequent hemorrhage. The patient expired, pain-free until the end.

EVALUATION OF STUDY

Definite relief of local pain followed the application of subnormal temperatures in the region of active growth complicated by pain. There was apparent gross retardation in growth as well as diminution in the size of the carcinomatous lesion in the cases so far treated.

Dr. Lawrence Smith summarizes the microscopic changes noted in tissues obtained from this group of cases as follows:

"In a study of the tissues removed from a preliminary series of 5 patients who have been treated by chilling the tissues over a considerable period of time, by one or another of the instruments described, it has been found that more marked degenerative and necrotic changes seem to occur in the treated lesions than were present in the original biopsy material or in other untreated metastatic foci. With the amount of ma-

terial thus far available, it is impossible to state whether or not these changes will occur regularly or whether they are merely coincidental. It is of interest in this connection to note that in one of the cases (Case 3), an instance of breast carcinoma, similar degenerative lesions occurred around the point of insertion of the instrument, suggesting that the relative avascularization occasioned by prolonged chilling may well play a part in the development of such retrogressive tissue changes."

Important observations relative to thermal influence of the blood-forming organs in mammals and birds have been noted by Huggins, Blockson, and Noonan.¹ Loss of red bone marrow function occurred in the periphery exposed to low temperatures, activity being retained when the thermal levels approached those of the deep body areas.

Blood cells may be considered as products of a normal "metastatic tumor," the bone marrow. Observations relative to the response of this tissue may be of significance in the consideration of malignant cellular proliferation. The fields of malignant cellular activity (according to Geschickter's chart) closely correspond to the selective fields of higher temperature requirements of red bone marrow. The peripheral fields of lower segmental temperature are apparently unfavorable for rapid activity of either "normal" or "malignant" cell proliferations.

SUMMARY

1. Segmental body temperatures vary in the normal individual and there is a striking elevation of temperature in the region of the breast segments, fourth and fifth thoracic, when compared with adjacent areas of the thorax.

2. The incidence of metastatic malignancy lies almost entirely within the zone of higher segmental temperatures of the body (Fig. 22) whereas the distal portions of the extremities rarely harbor metastatic lesions. These portions represent the lowest segmental temperatures recorded.

¹Huggins, C., and Blockson, B. H., Jr. Changes in outlying bone marrow accompanying a local increase of temperature within physiological limits. *J. Exp. Med.*, 1936, 64, 253.

Experiment to determine the relative response of bone marrow in the distal bones with changes in temperature. "A common factor in all of the experiments was an elevation of temperature beyond that prevailing in these distal regions and it is felt the evidence warrants the opinion that the cause of the improvement is thermal."

Huggins, C., and Noonan, W. J. An increase in reticulo-endothelial cells in outlying bone marrow consequent upon a local increase in temperature. *J. Exp. Med.*, 1936, 5, 275.

"In adult mammals and birds there is a great quantitative difference in the reticulo-endothelial system content of the bone marrow of the central bones as compared with the distal outlying bones." After an intravenous injection of India ink it was at once apparent in all mature mammals studied, that the amount of carbon taken up by the central bones was much greater as compared with that of the outlying bones of the extremities (limbs and tail).

in the normal, as well as in the pathological, cases so far studied

3 In the hopeless and far advanced cases of metastatic malignancy where pain was a prominent symptom the method of refrigeration, when applied to the area of involvement, brought about prompt and gratifying relief of pain Temporary improvement in the general nutritional state of the patient was also noted

4 Where the principle of "refrigeration" has been applied directly to the region of the malignant growth, certain favorable gross clinical and pathological changes have been noted in those cases so far studied

5 The principle of "hibernation" was induced in one case in this series by means of radiation to the pituitary, thyroid, and ovarian glands A fall

of 20 per cent in the basal metabolic rate followed with a corresponding fall in segmental surface temperature Widespread metastatic lesions disappeared within 3 weeks and at the present time (9 months following treatment) the patient is free from the symptoms of malignancy

Further observations, both as to comparative biopsy studies of the cell areas treated by "refrigeration," as well as controlled tissue growth *in vitro*, under various "critical" thermal levels will be presented later by Dr Lawrence Smith and his staff

The authors wish to express their indebtedness to Dr Lawrence Smith professor of pathology Dr W Edward Chamberlain professor of roentgenology and Dr Augustus McCravey fellow in the International Cancer Research Foundation for their assistance advice and critical analyses in this problem

PAGET'S DISEASE OF THE NIPPLE

Sir GEORGE LENTHAL CHEATLE, K C B., C.V.O., F.R.C.S., F.A.C.S. (Hon.), London, England

IN 1874, Sir James Paget described superficial changes on the surface of the nipple which became known as "Paget's disease of the nipple." Sir James also stated that these signs were often associated with carcinoma of the breast. Hence a description of Paget's disease naturally divides itself into first a description of the superficial changes and second of the conditions of the underlying breast. Emphasis should be laid upon the fact that no history of a case of Paget's disease is complete unless the state of the underlying breast is included.

SUPERFICIAL CHANGES

The superficial changes are a slowly spreading, rosy red, dry rash covered by fine, white scales, and with a hard defined edge. It should be understood that Paget described purely the clinical picture and that he did not publish a description of the microscopical appearance of the rash. His colleagues, Butlin and Bowlby, made the earliest such descriptions but they were indeterminate in character. The finding which they emphasized was the presence of certain large cells with clear cytoplasm and lateral and often crescentic nuclei, these cells received the dignified name of "Paget's cells." Their nature probably gave rise to a greater amount of speculation than they deserved. Some people for a time regarded them as psorosperms and believed that they were the cause of all the trouble associated with their presence.

Dr. R. J. Ludford has recently examined these cells from a cytological standpoint. He concluded that they arose in the basal layers of the epidermis. A cell will first enlarge, then undergo mitosis, and the daughter cell will eventually desquamate. Dr. Ludford regards "Paget's cells" as degenerative. Whether they are or are not genetically related to the carcinoma cell with which they are often associated is by no means clear. It is not known whether they appear before or after the carcinoma.

The classical clinical signs enumerated by Paget are caused by different types of disease, hence, it appears that the cause should be determined on merits of each example after microscopical study.

From the Kings College Hospital, London and the Chicago Tumor Institute

Presented in the Symposium on Cancer, before the Clinical Congress of the American College of Surgeons, Chicago, October 25-29, 1937

Some of these lesions are described as follows:

1. Jacobaeus and more recently Sir Robert Muir have pointed out with truth that the most frequent cause of the surface lesion is a direct spread of carcinoma cells, arising from the upper duct, into and among the normal epidermic cells of the nipple surface where they remain confined to the normal boundaries of the epidermis for considerable periods. The surface of the nipple often is lined with these cells when the normal epidermis has been shed. The nipple becomes level with the areola chiefly by its atrophy and retraction. This type of duct carcinoma is always non-papillomatous and can be distinguished as causing the surface disease in 15 of 19 cases exhibiting the classical signs of the superficial disease. In 13 of the 19 cases "Paget's cells" were also present. In 3 of the 16 cases there were no changes in the underlying breast. Except in 2 cases no anatomical continuity existed between the carcinoma of the upper ducts and other changes that occurred in the remaining cases. This lesion, being the most commonly associated with the surface changes, was most probably occurring in the cases described by Paget.

It would be interesting to be able to state definitely how far only the intra-epidermal spread from an upper duct carcinoma can extend. I believe that it is capable of only limited extension. When clinical signs of Paget's disease extend to opposite side, for example, the extension consists in the formation of Paget's cells that Ludford described and contains no breast carcinoma cells.

The carcinoma in the upper duct which always exists may extend downward in the duct for a considerable distance but a place is reached where the extension downward ceases and there is an interval of varying length in different cases of normal duct before the epithelial neoplastic lesions in the depths of the breast are reached. This statement is true for all my cases except 2 in which the epithelium of the whole breast from the upper ducts downward was in a state of carcinoma.

The malignancy of the carcinomas of the upper ducts in all the 16 cases was of a low grade and no lymphatic vessels below the epidermis were invaded except in 1 instance the subdermal vessels were invaded but the axillary glands were free.

2. "Paget's cells" alone can be seen in the epidermis of the superficial lesion exhibiting the

classical clinical signs of the disease. As before indicated, Dr Ludford regards them as being degenerative. I have 1 case in which only Paget's cells can be detected on the nipple surface and no carcinoma can be seen in an upper duct, but the neoplastic epithelial changes in the underlying breast are remarkable. They look like carcinoma and the natural boundaries of terminal ducts and acini are greatly distended but not transgressed. There is no direct continuity between these deep changes and the superficial lesion, and no superficial duct carcinoma could be detected.

3 A carcinoma arising not in the upper duct but spreading upward from elsewhere in the breast can give rise to the signs of Paget's disease by causing shedding of the epidermis and appearing on the surface of the nipple.

4 Carcinoma of the sebaceous glands on the surface of the nipple have caused the clinical signs of Paget's disease. I have one such case.

No "Paget's cells" appear in types 3 and 4. At present it is impossible to say whether the superficial lesions of types 1 and 2 precede or follow those of the underlying breast.

NEOPLASTIC CHANGES IN DEPTHS OF BREAST

Lesions of the deep structures may be described as follows:

1 This type is remarkable in that the epithelial neoplasia distends, but does not penetrate natural boundaries. Despite this fact the condition looks malignant. It occurs chiefly in the terminal ducts and acini, not in the acini alone, and in more than one part of the breast. The changes in the ducts are often papillomatous. There is no evidence whatever to show the existence of a direct anatomical continuity of disease between the epithelial neoplasms in the depths of the breast and the non papillomatous duct carcinoma in the upper ducts. In one case I could detect only the formation of Paget's cells on the nipple surface and could not discover a carcinoma in the upper duct region. In the depths of this breast were found marked epithelial neoplastic developments in the terminal ducts and acini which were distended by them but there was no transgression of their normal boundaries. In some instances benign looking papillomas exist in the ducts of middle caliber while carcinoma exists in the deeper distribution of the duct.

2 Definite carcinoma has established itself sometimes in one part only and more rarely in two or more parts. The lesions are found to occur chiefly in the terminal ducts and acini which are separated from the carcinomas in the upper duct by intervening, perfectly normal ducts. The type

is often papillomatous and is much more malignant than its accompanying non papillomatous lesion in the upper duct or ducts. The lymphatic glands in the axillæ are usually affected.

From our description it will have been seen that in type 1 of the surface lesions, carcinoma of the upper duct may extend upward within the epidermis and downward into the duct, also that there are usually changes in the underlying breast which in some instances are definitely carcinomatous and in others the epithelial neoplasias are confined within normal boundaries and cannot be described as being carcinomatous.

DISCUSSION OF FINDINGS

Reference is here made only to those cases in types 1 and 2 in the surface lesions. In all except 2 of these cases a very definite and varying length of the duct connecting the upper and lower lesions remained normal. In the 2 cases just mentioned in which the whole breast epithelium was in a state of carcinoma the diseased condition was too chaotic to form any opinion as to its origin. In the other cases, the upper and lower lesions appeared to be separate foci of disease for important reasons, as follows: the upper lesion may exist without deeper epithelial neoplastic changes in the depth of a breast, the deeper lesion may exist and yet there may not be carcinoma but only Paget cell formation on the surface of the nipple; the deeper lesions may not be definitely carcinomatous although those in the upper ducts are carcinomatous; the carcinoma of the depths is much more malignant than that of the surface, and the disease of the depths, whether benign or malignant, is often papillomatous whereas that of the surface lesion is always non papillomatous.

The answers to the questions (a) why should there be separate lesions or (b) why should there be 2 lesions at all, are wrapped in mystery.

Continuity of growth, either downward or upward and transplantation, do not explain their separate existence. Can it be that inducing agents of disease can pass downward from the surface to reach the underlying breast or can they reach it via the blood stream?

SUMMARY

1 The classical signs of Paget's disease refer to several separate conditions.

2 The description of Paget's disease of the nipple is incomplete unless the conditions of the underlying breasts be also described.

3 These conditions have been given.

4 The merits of each case should be decided after the examination of whole microscopic sections of the breast including the nipple.

THE TREATMENT OF CANCER OF THE RECTUM

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WHEN first I began to practice surgery and to assist the late Herbert Allingham of St Mark's Hospital, excision of the rectum for cancer was a horrible operation and the results were very bad. Two methods were in vogue.

First, for a growth low down in the bowel the rectum together with the growth was dissected free from the surrounding tissues, the surgeon's left forefinger inside the rectum being used as a guide. The bowel was divided above the growth and the stump was brought into the upper angle of the wound and sutured to the skin. The large wound was left open and packed with gauze. No preliminary colostomy was performed. A great deal of suppuration occurred and the patient was usually confined to bed for 4 to 6 months, and the result, if the patient survived, was that the bowels acted through a fecal fistula in the situation of the coccyx. There was no control and considerable prolapse of mucous membrane was common.

The other method was that first advocated by Kraske. The coccyx and part of the sacrum were removed, and the rectum was exposed by incising all the tissues posterior to it. That portion of the rectum containing the growth was cut out and the ends were joined together over a rubber tube, the back wound being partly closed. The join in the rectum almost invariably broke down, there was considerable sepsis, and if recovery took place, there was often a bad stricture at the point of union and a fecal fistula behind. Not only were the immediate results unsatisfactory, but the ultimate results were bad. Early recurrence of the growth was frequent and the functional results were poor.

The two factors which chiefly handicapped the surgeon at that time were shock and sepsis. However carefully the operation was performed, or however satisfactory the result appeared at the end of the operation, subsequent sepsis broke everything down and spoiled the most carefully planned operation. To escape from these difficulties we performed a preliminary colostomy and so redesigned the operation that it could be performed without soiling the wound. A very great improvement in the results was immediately obtained, and the mortality in my own cases per-

formed by the perineal method, which I first described in 1920, came down to about 6 per cent. Since then steady progress has been made in improving the operation and reducing risks, so that today my mortality for private patients operated upon by the perineal route is only 4 per cent for the last 150 operations.

Primary sepsis should no longer occur, but a large cavity is inevitably left by the removal of the rectum which has to heal slowly by granulation.

The perineal operation for cancer of the rectum is now an established procedure for growths of the rectum proper and has shown the best results of any method for growths situated in the ampulla or lower part of the rectum. It is not, of course, suitable for growths at the upper end of the rectum, where some form of combined operation is necessary.

For a long time the abdominoperineal operation, which has been described by Miles, was the usual method employed for high growths, but in recent years better results have been obtained by doing the perineal part of the operation first and finishing in the abdomen. There are still differences of opinion as to the exact technique to be employed in dealing with tumors at the upper end of the rectum, but my own preference is for a two-stage operation with preliminary colostomy and removal of the rectum by the perineo-abdominal route. I have completed this operation in 55 minutes and consider it both quicker and easier than the abdominoperineal technique.

When we are discussing the relative values of different kinds of treatment for the same disease, it is obvious that it is both undesirable and impossible to arrive at any satisfactory conclusion until a considerable number of cases have been traced over a long period of years. I think everyone will agree that we are not justified in claiming any case of cancer as cured unless the patient is alive at least 5 years after the removal or disappearance of the growth. Many cases are claimed as cures on a 3 years' basis, but it is becoming increasingly evident that this period of time is too short and that at least 5 years' survival is necessary before we can claim a cure. It is a debatable point whether one is ever justified in using the word "cure" in such a disease as cancer, and in taking 5 years' survival as a cure, we have to bear in mind that it is merely a conventional phrase. Practically it is necessary, if we are to gain any

accurate knowledge of the relative values of different operations and methods of treatment, that we should take some definition of cure, and I think it will be generally agreed that a 5 years' survival period is the best compromise.

Fortunately, the results in a very large number of cases are now available, and it is a recognized principle both in the best hospitals here and in London, that when the results of operations for cancer of the rectum are published the cases should be traced for a period of 5 years or longer. I do not propose to trouble you with a great mass of statistics; moreover the personal experience of one man is probably of more interest than the accumulated experience of many, provided the figures are large enough, and it has the further advantage that a more or less uniform technique has been used in all the operations.

As regards the perineal operation in two stages there are 388 cases. The immediate mortality was in the private cases only $4\frac{1}{2}$ per cent and in the hospital cases 10 per cent.

The increased mortality in the hospital cases is, I am sure, not accounted for by any difference in the quality of the nursing or facilities for after treatment, but by the fact that as a rule hospital patients present themselves for treatment at a more advanced stage of the disease than the private patients, and that they are in poorer general condition. This is, I think, proved by the fact that the St. Mark's Hospital statistics show that there was no immediate mortality at all among those hospital cases in which patients were operated upon before the tumor had passed through the rectal wall and invaded the neighboring tissues, all the deaths occurring in the advanced cases.

You will see, therefore, that the risks of the operation are not serious, as $4\frac{1}{2}$ per cent may be considered a low operation risk for a severe operation on persons whose average age is well over 60 years.

The combined operation for growths at the upper end of the rectum does not show such good results as regards operative risk. The fact that the operation necessarily takes considerably longer and that it involves interference with the abdominal cavity, no doubt accounts for the difference. It must also be remembered that surgeons are obliged, in bad borderline cases when the tumor is large and there are many glands, to use the combined method, as sufficient removal cannot be ensured by the perineal route alone, there thus being a tendency for the perineal operation to be chosen in favorable cases and vice versa. The mortality rate for the combined operation as we now perform it at St. Mark's Hospital is about 20 per cent.

It will be evident that from the point of view of the immediate risks of the operation the perineal method gives the best results, but another factor which is quite as important is the recurrence rate. It is no use performing an operation with a low operation risk if the patient is going to get early recurrence of the tumor.

There are 142 patients who have survived the operation 5 years or more, giving a percentage cure on a 5 years basis of $52\frac{1}{2}$ per cent.¹ It is interesting to note that there are in all 58 patients who have survived the operation 10 years or longer. The figures for the combined operation show only 28 per cent cures so that the perineal operation comes out as the best on both counts. For this reason my usual practice now is to make use of the perineal operation for cases in which the growth is confined to the rectum only, and to use the combined operation for cases in which the growth is at the rectosigmoid junction, and in advanced cases in which adequate removal can not be obtained by the perineal route.

The most interesting results, however, are seen when we study those cases that have been graded. There are two methods of grading now in use: Dr. Broder's method and Dr. Cuthbert Dukes's.

Broder's method. This relies upon the amount of differentiation of the cells comprising the tumor as seen under the microscope. Actually we have found that the decision as to the grade of malignancy depends more on the relative arrangement of the cells than on the number of so called undifferentiated cells. This method has the advantage that it makes it possible by examining biopsy specimens before operation to obtain some idea of the type of tumor with which we have to deal. The examination of a single specimen is not very trustworthy and several removed from different parts of the tumor should be examined if possible.

The result of grading 600 cases by this method at St. Mark's Hospital gives the following:

50 per cent of the cases were found to be in Grade 2
26 per cent of the cases were found to be in Grade 3
12 per cent of the cases were found to be colloid growths
6 per cent of the cases were found to be in Grade 1
2 per cent of the cases were found to be in Grade 4

When these cases were traced it was found that the survival rate in the first 3 years was—

	Per cent
Grade 1	80
Grade 2	65
Grade 3	52
Grade 4	34
Colloid growths	60

¹In calculating these figures patients dying from other causes than cancer or who are untraced are disregarded.

This shows that the patient's chances are better for Grades 1 and 2 than for the other grades

This form of grading, while certainly useful, leaves entirely out of account the most important factor from the point of prognosis, namely, the extent of spread of the tumor at the time of operation

Dukes's method This method depends upon the extent of invasion of the surrounding tissues at the time of removal of the tumor. The whole removed rectum is carefully dissected and the limits of the growth are defined. All glands are examined microscopically and their situation is charted, and all veins are also examined. The tumors are then graded A, B, and C. This histological method of grading has only been in use since 1928.

The survival rate on a 5 years' basis of cases thus graded shows:

93 per cent survival in A
65 per cent survival in B
23 per cent survival in C

This demonstrates what might have been expected, namely, that the prognosis from operation is in direct proportion to the stage which the growth has reached at the time of operation, but it was not till these results had been worked out that we realized the enormous importance of early operation. If the growth can be removed by operation while it is still in the A stage, the chance of a cure on a 5 years' basis is approximately 100 per cent, while if it has reached the C stage, it is under 25 per cent.

Still another important fact emerges from these figures. The operative risk is in direct proportion to the stage of the tumor at the time of operation, almost all the operative deaths having occurred in the C cases.

We can hardly hope by operation to obtain better results as regards the cure of cancer of the rectum in cases in which the tumor is still in the early stage at the time of operation, and we must now concentrate on attempting to improve our results by (1) getting the patients to submit themselves for treatment at an earlier stage of the disease when the prognosis is good, and (2) improving our treatment of those cases which are in the advanced stage of the disease when they are first seen.

Unfortunately, the latter cases still form the great majority of the total and it is deplorable that we seem to have no means at our disposal of remedying this state of affairs. It is sad to think that we have discovered how to treat cases of cancer of the rectum so successfully as to cure just on 100 per cent, but that we are not able to apply treatment to more than a small percentage

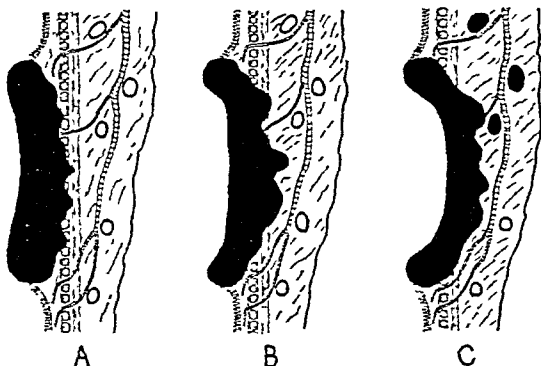


Fig. 1. A, Growth limited to wall of rectum. B, Extension of growth to extrarectal tissues but no metastases in regional lymph nodes. C, Metastases in regional lymph nodes (Reproduced by kind permission of Dr. Cuthbert Dukes from "Histological Grading of Rectal Cancer," *Proc Roy Soc Med*, 1937, 30: 25-30)

of the total cases for reasons which are outside our control.

TREATMENT BY RADIUM AND X-RAYS

No satisfactory statistics are here available. There are several reasons for this. The early cases of cancer of the rectum treated by radium were so unsatisfactory that for a time the treatment was almost abandoned, and it is only in the last few years that any real success has been achieved.

The earlier cases were all treated by radium needles and with large doses acting for a short period. The result was almost invariably extensive sepsis and sloughing. Occasionally a good result was obtained, and there are a few patients who have survived 5 years, but most of them were made worse rather than better. The practice now is to use much smaller doses, acting over a longer period, and my own practice and that of most of my colleagues is to use radon seeds instead of needles.

I can give you today only my own opinion with regard to this form of treatment, for what it is worth. In cases in which the tumor is so advanced that operative removal is contra-indicated radium and x-rays are of no use. In fact my own experience would tend to show that by such treatment the unfortunate patient is only rendered more unhappy and distressed without any material prolongation of life.

In cases in which the tumor is in an early stage, but owing to advanced age, concomitant disease, or even total refusal of the patient to submit himself to operative removal, operation is impossible, radium may be used with success. I have seen quite a number of small, early, rectal carcinomas

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION

Private Cases

Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
1	1905	M	37	C	R	22 yrs In 1923 a new growth occurred in upper part of rectum the second growth was excised Fatie died in 1928
2	1912	M	50	A	R	17 yrs d o c Jan 1929
3	1913	F	68	A	R	8 yrs 4 years after had duct cancer of the breast which was removed d ed 1921 from apoplexy
4	1915	M	60	B	R	7 yrs d o c 1922
5	1915	M	62	B	R	5 yrs d o c 1920
6	1916	M	52	A	R	5 yrs D ed of recurrence
7	1916	F	75	A	R	6 mos d o c
8	1916	M	63	A	R	2 yrs Died of recurrence in liver
9	1916	M	5	B	R	9 mos Died of recurrence
10	1916	M	43	A	R	12 yr In Oct 1929 devel ped and P T which was ope ated upon. D
11	1917	M	66	B	R	15 yrs Untraced s ope 31 y 1932
12	1917	M	69	B	R	2 yrs d o c
13	1917	M	62	B	R	2 yrs D ed of recurrence
14	1917	F	63	B	R	2 yrs Died of recurrence in pelvis
15	1917	M	68	B	R	6 mos. Died of recurrence
16	1917	M	68	A	R	5 yrs Untraced since
17	1917	M	57	A	R	14 yrs d o c 1931
18	1917	M	53	A	R	7 yrs Died 1 and P T in col n which recurred after removal
19	1917	M	57	A	R	15 yrs d o c 1932
20	1918	M	55	B	R	15 yrs.
21	1918	F	4	C	R	6 yrs Died of recurrence in vag na
22	1918	F	62	A	R	2 yrs Died of recurrence
23	1918	F	58	B	R	3 yrs D ed of recurrence
24	1918	M	50	B	R	4 yrs D ed of recurrence
25	1918	F	50	B	R	3 yrs Died of recurrence in col n
26	1918	F	36	B	R	1 yr D ed of recurrence in vag na
27	1918	F	50	B	R	1 yr d o c
28	1918	F	46	A	R	17 yrs (h d Gr ves disease for 20 yrs)
29	1918	F	54	A	R	2 yrs Recurrence in lumbar gl nds
30	1919	M	56	B	R	18 yrs
31	1919	M	72	B	R	13 yrs d o c 1931
32	1919	M	51	B	R	17 yrs Died of recurrence
33	1919	M	64	B	R	17 yrs Died of recurrence Had Hodgkins disease at time of operation
34	1919	M	54	A	R	18 yrs
35	1919	F	67	B	R	18 yrs
36	1919	M	54	B	R	9 yrs d o c
37	1920	F	34	B	R	4 yrs Died of recurrence
38	1920	F	32	A	R	13 yrs D ed of recurrence
39	1920	F	40	B	R	17 yrs
40	1920	F	43	A	R	10 yrs
41	1920	F	52	A	R	13 yrs. Untraced s
42	1920	M	51	C	R	1 yr Recurrence in lumbar veins
43	1920	F	63	B	R	4 yrs Recurrence in liver
44	1920	F	63	B	R	4 yrs
45	1921	M	72	A	R	5 yrs d o c during 6th yea
46	1921	F	46	A	R	7 yrs. Recurrence in sacral glands
47	1921	M	61	B	R	7 yrs Untraced s ope
48	1921	F	54	B	R	3 yrs. Recurrence
49	1921	M	61	A	R	3 yrs
50	1921	M	52	A	R	1 yrs. Untraced s ope
51	1921	F	53	C	R	4 yrs Recurrence
52	1921	M	62	A	R	3 yrs Recurrence
53	1921	M	60	A	R	4 yrs d o c
54	1921	M	60	A	R	4 yrs Recurrence
55	1921	F	58	A	R	3 yrs Recurrence
56	1921	M	51	C	R	Few m this later local recurrence d ed after x r y beam

A, very favorable B, med cases C, border-line cases D, death from operation R, recovery from operation D.O.C., d ed from other causes and P.T., and primary tumor

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Private Cases

Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
57	1922	M	47	B	R	3 yrs Recurrence
58	1922	F	46	A	R	17 yrs In 1924 had s d P T removed and f d am applied
59	1922	F	30	C	R	2 yrs. Recurrence
60	1922	M	63	C	R	Sepsis
61	1922	M	35	A	R	3 yrs Recurrence
62	1922	M	46	A	R	15 yrs
63	1922	F	47	B	R	3 yrs Recurrence
64	1922	F	75	C	R	Heart fail re 3 wks after operation
65	1922	M	56	B	R	3 yrs D ed of 2nd P T in lung
66	1923	M	45	B	R	3 yrs Recurrence
67	1923	M	64	B	R	11 yrs d o c
68	1923	M	54	B	R	Heart failure
69	1923	M	64	A	R	4 yrs d o c
70	1923	F	63	A	R	6 yrs D ed 1929 of 2nd P T in stomach
71	1923	M	59	A	R	1 yr Recurrence (had diabetes and diverticulit s)
72	1923	F	60	A	R	3 yrs d o c
73	1923	F	70	B	R	6 yrs d o c
74	1923	F	68	C	R	1 yr Recurrence
75	1923	F	61	B	R	12 yrs.
76	1923	M	60	B	R	3 yrs Recurrence in liver
77	1923	F	60	A	R	8 yrs Died probably and P T
78	1923	F	50	A	R	12 yrs d o c
79	1923	M	56	A	R	Untraced since operation
80	1923	M	73	B	R	13 yrs
81	1924	M	73	B	R	4 yrs Recurrence
82	1924	M	57	B	R	Recurrence
83	1924	M	65	B	R	13 yrs
84	1924	F	71	B	R	2 yrs d.o.c.
85	1924	M	64	B	R	2 yrs Recurrence
86	1924	M	50	B	R	6 yrs d o c
87	1924	M	64	B	R	Untraced since operation Went to Australia
88	1924	M	67	B	R	13 yrs
89	1924	F	64	A	R	13 yrs Recurrence
90	1924	F	56	A	R	11 yrs
91	1924	M	56	A	R	5 yrs Recurrence during 6th year
92	1925	F	62	A	R	8 yrs October 1933 developed growth in teru f and P T died
93	1925	F	58	B	R	7 yrs Untraced since
94	1925	M	53	B	R	7 yrs nd P T in go atestine Died
95	1925	F	58	B	R	3 yrs Recurrence in liver
96	1925	F	59	B	R	3 yrs Recurrence
97	1925	M	73	B	R	1 yr Recurrence
98	1925	F	75	B	R	3 yrs Recurrence ce abdomen
99	1925	M	65	C	R	1 yr Recurrence
100	1925	F	71	C	R	De el ped secondaries in brain 9 mot after oper 1 m
101	1925	F	58	C	R	4 yrs Recurrence
102	1926	M	72	A	R	Untraced since operation
103	1926	M	55	A	R	10 yrs
104	1926	M	69	B	R	4 yrs Recurrence
105	1926	M	50	A	R	9 yrs Untraced since
106	1927	F	44	B	R	10 yrs.
107	1927	M	67	B	R	1 yr Recurrence in liver
108	1927	M	45	A	R	8 y s. Untraced s ope
109	1927	M	59	A	R	7 yrs d o c
110	1927	F	67	A	R	4 yrs Developed epith homa t a us died
111	1927	F	64	f	R	8 yrs
112	1928	F	70	B	R	Bro chitis s d heart failure
113	1928	M	45	A	R	8 yrs
114	1928	F	6	B	R	3 yrs Recurrence
115	1928	F	71	B	R	6 yrs d e
116	1928	F	71	A	R	7 yrs d e
117	1928	F	71	B	R	D ed of py l t us short time after operati
118	1928	M	60	C	R	2 yrs Seco daries in liver

*Ep th oma

15Sarcoma

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Private Cases

Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
119	1928	M	50	A	R	8 yrs
120	1928	M	72	A	R	7 yrs
121	1928	M	50	A	R	2 yrs Died of cancer pyloric end of stomach
122	1928	F	62	C	R	2 yrs Died recurrence
123	1928	M	50	C	R	9 yrs
124	1928	M	54	A	R	4 yrs d.o.c.
125	1928	M	70	A	R	2 yrs Recurrence
126	1928	M	55	A	R	7 yrs
127	1929	M	66	A	R	7 yrs
128	1929	M	48	C	R	2 yrs Recurrence
129	1929	M	55	A	R	5 yrs Recurrence April, 1935
130	1929	F	52	A	R	7 yrs
131	1929	M	50	A	R	2 yrs Recurrence
132	1929	M	62	B	R	8 yrs
133	1929	F	67	B	R	2 yrs Recurrence
134	1929	M	72	C	R	Recurrence 6 mos later
135	1929	F	67	C	R	Untraced since June, 1930
136	1929	M	54	C	R	3 yrs Recurrence in liver
137	1929	M	79	A	R	4 yrs d.o.c.
138	1930	F	48	C	R	2 yrs Recurrence in spine
139	1930	M	61	B	D	Heart failure
140	1930	M	69	C	R	3 yrs Recurrence
141	1930	F	60	C	R	Recurrence a few months later
142	1930	F	57	B	R	1 yr Recurrence
143	1930	F	60	C	R	2 yrs Recurrence
144	1930	M	63	A	R	6 yrs
145	1930	M	71	A	D	Dilatation of stomach
146	1930	M	75	A	R	5 yrs Recurrence in lung during 6th year
147	1930	F	55	C	R	1 yr Secondaries in liver
148	1931	F	68	C	R	1 yr d.o.c.
149	1931	F	56	A	R	3 yrs Untraced since Jan., 1931
150	1931	F	40	B	R	5 yrs
151	1931	M	53	C	R	1 yr Recurrence in spine and sacrum
152	1931	M	44	C	R	5 yrs
153	1931	M	57	B	R	1 yr Recurrence
154	1931	M	58	A	R	5 yrs
155	1932	M	51	C	R	5 yrs
156	1932	M	65	C	D	Heart failure
157	1932	M	60	B	R	4 yrs Recurrence
158	1932	F	61	B	R	5 yrs
159	1932	F	68	A	R	5 yrs
160	1932	M	70	B	R	5 yrs
161	1932	M	57	C	R	2 yrs Recurrence in spine
162	1932	F	68	C	R	5 yrs
163	1932	M	62	C	R	5 yrs
164	1932	F	63	B	R	5 yrs
165	1932	F	59	B	R	4 yrs Recurrence in liver
166	1932	M	50	A	R	5 yrs
167	1933	M	66	C	R	1 yr Recurrence in spine
168	1933	M	44	A	R	4 yrs Well to date
169	1933	M	65	A	R	4 yrs Recurrence in liver
170	1933	M	60	A	R	4 yrs Well to date
171	1933	M	65	A	R	4 yrs
172	1933	M	62	B	D	Cardiac embolism
173	1934	M	54	C	R	Aug., 1935 Secondaries in brain
174	1934	M	51	A	R	3 yrs
175	1934	F	44	C2	R	3 yrs
176	1935	F	60	C	R	1 yr Recurrence in colon
177	1935	M	50	C2	R	1 yr Recurrence
178	1935	M	56	C2	R	Well to date
179	1935	F	53	C1	R	Well to date
180	1935	M	65	B	R	1 yr d.o.c.
181	1935	M	51	C2	R	1 yr Recurrence
182	1935	M	67	B	R	1 yr Recurrence in liver
183	1935	M	61	B	R	Well to date
184	1935	M	54	B	R	Well to date
185	1935	M	45	C2	R	1 yr Recurrence in liver
186	1936	F	61	C1	R	Well to date

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Private Cases

Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
187	1936	F	48	C1	R	Recurrence in liver 6 mos later
188	1936	F	47	C2	R	1 yr. Died secondaries in brain
189	1936	F	60	C2	R	1 yr. 2 has recurrence in liver
190	1936	F	62	C2	R	1 yr. Secondaries in liver
191	1936	F	68	B	R	Well to date
192	1936	M	57	B	R	Well to date
193	1936	F	54	B	R	Well to date
194	1936	M	68	C1	R	Well to date
195	1937	M	72	A	D	Static pneumonia (diabetic)
196	1937	F	67	B	R	Well to date
197	1937	M	58	B	R	Well to date
Hospital Cases						
198	1910	M	56	B	R	1 yr Recurrence
199	1911	M	59	A	R	15 yrs d.o.c.
200	1912	M	61	C	R	1 yr Recurrence
201	1913	F	50	B	R	Recurrence in a few months
202	1913	M	55	B	R	3 yrs. Recurrence
203	1913	M	62	A	R	1 yr. Recurrence
204	1914	M	53	B	R	6 yrs Recurrence
205	1915	M	49	B	R	21 yrs Died Aug., 1936 ² and P T
206	1915	M	61	B	R	1 yr d.o.c.
207	1915	M	50	B	R	12 yrs. d.o.c.
208	1915	F	43	B	R	2 yrs Recurrence
209	1915	F	45	B	D	Shock
210	1916	F	62	A	R	18 yrs d.o.c.
211	1916	M	65	B	D	Sepsis
212	1916	M	55	C	D	Hemorrhage (hemophilic)
213	1916	M	54	B	R	1 yr Recurrence
214	1916	M	40	B	R	2 yrs Recurrence in liver
215	1916	F	53	A	R	21 yrs
216	1916	M	52	B	R	21 yrs
217	1916	M	48	B	R	1 yr Recurrence
218	1916	M	48	A	R	20 yrs
219	1917	M	64	B	D	Sepsis
220	1917	F	34	A	R	5 yrs Recurrence
221	1917	F	62	C	D	Sepsis
222	1917	M	35	A	R	3 yrs Untraced since
223	1917	M	55	A	R	10 yrs Died 1933 probably and P T in liver
224	1917	M	59	A	R	19 yrs.
225	1917	M	59	A	R	3 yrs Recurrence
226	1917	F	43	A	R	3 yrs Recurrence
227	1918	M	43	B	R	6 yrs Recurrence in liver
228	1918	M	57	B	R	2 yrs Recurrence
229	1918	F	45	B	R	19 yrs
230	1918	M	47	B	R	2 yrs Recurrence
231	1918	M	47	A	R	2 yrs d.o.c.
232	1918	M	60	A	R	18 yrs d.o.c.
233	1918	M	54	A	R	3 yrs Recurrence in liver
234	1918	F	45	C	R	5 yrs. Died and P T of breast
235	1918	F	57	C	R	1 yr Recurrence
236	1918	M	59	A	R	2 yrs Recurrence
237	1918	M	62	A	R	5 yrs d.o.c.
238	1918	M	57	A	R	9 yrs d.o.c.
239	1919	M	66	A	R	16 yrs. Died? recurrence
240	1919	M	50	A	R	1 yr Recurrence
241	1919	F	26	A	R	1 yr Recurrence in liver
242	1919	F	66	B	R	2 yrs. Recurrence in vagina
243	1919	M	46	A	R	15 yrs
244	1919	M	29	A	R	1 yr Recurrence
245	1919	F	56	B	R	9 mos. Recurrence
246	1919	F	59	B	R	1 yr Recurrence
247	1919	M	54	B	R	2 yrs Recurrence
248	1919	F	63	B	D	Ascending pyelonephritis
249	1919	F	45	B	D	Sepsis

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION

Private Cases								
Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks		
1	1905	M	37	C	R	23 yrs. In 1923 a new growth occurred in upper part of rectum the second growth was excised P.T. died in 1938		
2	1912	M	60	A	R	17 yrs. d.o.c. Jan 1929		
3	1913	F	68	A	R	8 yrs. 4 years after h.d. diet cancer of the breast which was removed died 1921 from apoplexy		
4	1915	M	62	B	C	R	7 yrs. d.o.c. 1922	
5	1915	M	62	B	C	R	5 yrs. d.o.c. 1920	
6	1916	M	52	A	R	1 yr.	Died of recurrence	
7	1916	F	75	A	C	R	6 mos. d.o.c.	
8	1916	M	61	A	C	R	2 yrs.	Died of recurrence in liver
9	1916	M	52	B	R		9 mos.	Died of recurrence
10	1916	M	43	A	R		12 yrs.	In Oct 1930 developed and P.T. which was operated upon D
11	1917	M	66	B	R	R	15 yrs.	Untraced since May 1932
12	1917	M	67	B	R	R	2 yrs.	d.o.c.
13	1917	M	53	B	R	R	2 yrs.	Died of recurrence
14	1917	F	63	B	R	R	2 yrs.	Died of recurrence in pelvis
15	1917	M	68	B	R	R	6 mos.	Died of recurrence
16	1917	M	68	A	R	R	5 yrs.	Untraced since
17	1917	M	57	A	R	R	14 yrs.	d.o.c. 1931
18	1917	M	53	A	R	R	7 yrs.	Died of and P.T. in colon which recurred after removal
19	1917	M	57	A	R	R	15 yrs.	d.o.c. 1932
20	1918	M	55	B	C	R	18 yrs.	
21	1918	F	40	A	R	R	6 yrs.	Died of recurrence in vag. na
22	1918	F	62	A	R	R	2 yrs.	Died of recurrence
23	1918	F	58	B	R	R	3 yrs.	Died of recurrence
24	1918	M	50	B	R	R	4 yrs.	Died of recurrence
25	1918	F	36	B	R	R	3 yrs.	Died of recurrence in col. n
26	1918	F	36	B	R	R	1 yr.	Died of recurrence in vagina
27	1918	F	70	B	R	R	1 yr.	d.o.c.
28	1918	F	56	B	R	R	17 yrs.	(Had Graves' disease for 20 yrs.)
29	1918	F	44	B	R	R	2 yrs.	Recurrence in lumbar glands
30	1919	M	56	B	R	R	18 yrs.	
31	1919	M	72	B	R	R	11 yrs.	d.o.c. 1931
32	1919	M	51	B	R	R	6 yrs.	Died of recurrence
33	1919	M	64	B	R	R	6 yrs.	Died of recurrence Had Hodgkins disease at time of operation
34	1919	M	54	A	R	R	18 yrs.	
35	1919	F	67	B	R	R	18 yrs.	
36	1919	F	54	B	R	R	0 yrs.	d.o.c.
37	1920	F	54	B	R	R	4 yrs.	Died of recurrence
38	1920	F	52	B	R	R	14 yrs.	d.o.c.
39	1920	F	44	A	R	R	1 yr.	Died of recurrence
40	1920	F	60	B	R	R	17 yrs.	
41	1920	F	43	A	R	R	16 yrs.	
42	1920	F	57	A	C	R	13 yrs.	Untraced since
43	1920	M	51	B	R	R	1 yr.	Recurrence in lymphatic system
44	1920	F	63	B	R	R	4 yrs.	Recurrence in liver
45	1922	M	72	A	R	R	3 yrs.	d.o.c. during 6th yr.
46	1922	F	45	A	R	R	7 yrs.	Recurrence in sacral glands
47	1922	M	61	B	R	R	7 yrs.	Untraced since
48	1922	F	51	B	R	R	2 yrs.	Recurrence
49	1922	M	61	A	R	R	15 yrs.	
50	1922	M	52	A	R	R	12 yrs.	Untraced since
51	1922	F	52	C	R	R	4 yrs.	Recurrence
52	1922	M	62	A	R	R	2 yr.	Recurrence
53	1922	M	60	A	R	R	4 yrs.	d.o.c.
54	1922	M	60	A	R	R	4 yrs.	Recurrence
55	1922	F	53	A	R	R	3 yrs.	Recurrence
56	1922	M	52	C	R	R	Few months later local recurrence died after ray burn	

A, very favorable B, medium cases C, border line cases D, death from operation R, recovery from operation D.O.C., died from other causes and P.T., and primary tumor

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Private Cases						
Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
57	1922	M	47	B	R	3 yrs. Recurrence
58	1922	F	40	A	R	27 yrs. In 1954 had 2nd P.T. removed and radium applied
59	1922	F	39	C	R	3 yrs. Recurrence
60	1922	M	53	C	R	Sepsis
61	1922	M	58	A	R	3 yrs. Recurrence
62	1922	M	40	A	R	15 yrs.
63	1922	F	47	B	R	3 yrs. Recurrence
64	1922	F	75	C	R	Heart failure 3 wks after operation
65	1922	M	50	B	R	5 1/2 yrs. Died of 2nd P.T. in lung
66	1923	M	45	B	R	2 yrs. Recurrence
67	1923	F	64	A	R	11 yrs. d.o.c.
68	1923	F	64	A	R	Site of failure
69	1923	M	64	A	R	4 yrs. d.o.c.
70	1923	F	63	A	R	6 yrs. In Dec 1929 of 2nd P.T. in stomach
71	1923	M	59	A	R	1 yr. Recurrence (had diabetes and diverticulosis)
72	1923	F	60	A	R	3 yrs. d.o.c.
73	1923	F	70	B	R	8 yrs. d.o.c.
74	1923	F	68	C	R	Recurrence
75	1923	F	63	B	R	12 yrs.
76	1923	F	60	B	R	1 yr. Recurrence in liver
77	1923	F	60	A	R	8 yrs. Died probably 2nd P.T.
78	1923	F	50	A	R	12 yrs. d.o.c.
79	1923	M	50	A	R	Untraced since operation
80	1923	M	71	B	R	12 yrs.
81	1924	M	72	B	R	4 yrs. Recurrence
82	1924	M	63	B	R	1 yr. Recurrence
83	1924	M	65	B	R	13 yrs.
84	1924	F	71	B	R	2 yrs. d.o.c.
85	1924	M	64	B	R	2 yrs. Recurrence
86	1924	M	59	B	R	6 yrs. d.o.c.
87	1924	M	64	B	R	Untraced since operation Went to Australia
88	1924	M	67	B	R	13 yrs.
89	1924	F	61	A	R	6 yrs. Recurrence
90	1924	F	56	A	R	11 yrs.
91	1924	M	50	A	R	5 yrs. Recurrence during 6th year
92	1925	F	63	A	R	8 yrs. October 1933 died of growth in uterus 2 1/2 P.T. died
93	1925	F	58	B	R	7 yrs. Untraced since
94	1925	M	55	B	R	2 yrs. 2nd P.T. got stenosis Died
95	1925	F	58	B	R	3 yrs. Recurrence in liver
96	1925	F	53	B	R	3 yrs. Recurrence
97	1925	M	73	B	R	2 yr. Recurrence
98	1925	F	75	B	R	2 yrs. Recurrence in abdomen
99	1925	F	65	C	R	1 yr. Recurrence
100	1925	F	71	C	R	Died of secondaries in breast 9 mos after operation
101	1925	F	58	C	R	4 yrs. Recurrence
102	1926	M	72	A	R	Untraced since operation
103	1926	M	55	A	R	0 yrs.
104	1926	M	60	B	R	9 yrs. Recurrence
105	1926	M	59	A	R	9 yrs. Untraced since
106	1927	F	44	*†	R	1 yr.
107	1927	M	67	B	R	1 yr. Recurrence in liver
108	1927	M	45	A	R	8 yrs. Untraced since
109	1927	M	50	A	R	7 yrs. d.o.c.
110	1927	F	57	A	R	4 yrs. Developed epithelioma of anus died
111	1927	F	64	†	R	8 yrs.
112	1928	F	70	B	R	Bronchitis and heart failure
113	1928	M	45	A	R	8 yrs.
114	1928	F	63	B	R	7 yrs. Recurrence
115	1928	F	71	B	R	6 yrs. d.o.c.
116	1928	F	71	A	R	7 yrs. d.o.c.
117	1928	F	71	B	R	Died of pyelitis 1 1/2 years after operation
118	1928	M	60	C	R	2 yrs. Seco. of rectum in liver

*Epithelioma
†Sarcoma

entirely disappear after treatment with radium. In some of these cases there has been recurrence and the patients have been treated again; in some there has been no recurrence.

When, as sometimes happens, we see an adenocarcinoma of the rectum as large as a dollar entirely vanish in 3 to 4 weeks, leaving not even a scar behind, we see what, to my mind, is a modern miracle. By no other known means could such an amazing result be obtained!

In order to obtain it, however, it is necessary that exactly the right dose of radium should be given, and that all the seeds should be correctly placed. Unfortunately this is not easy to achieve. The correct dose for any individual tumor cannot be accurately estimated by any means now at our disposal, and the placing of the seeds is at best a somewhat haphazard performance. But we must not be discouraged. What can be done once, or a few times, can be done again, and our technique is improving.

At present radium should be used only in cases in which the tumor is easily accessible, so that the seeds can be more or less accurately placed, and only in cases in which operative removal is for some reason contra-indicated. We bring both our-

selves and the treatment into discredit if we attempt, even at the patient's urgent wish, to do the impossible by treating an inaccessible and unsuitable growth with radium.

My own practice is to scrape away as much of the growth as possible with a Volkmann's spoon, and then plant the seeds beneath and around the base as evenly as I can at 1 centimeter distance from each other, the dose being approximately 2 millicuries per centimeter with 0.5 screening.

Squamous epithelioma of the anal margin is in my opinion better treated by radium than by operation at the present day, and in such cases I now always advise radium.

As regards the use of x-rays or radium to prevent recurrence after operation, my own opinion is that they are of little use. It may satisfy the patient and his relatives, and help to distribute the responsibility in a bad case, but practically I do not think it is much good. Rays cannot be used on the liver, where most of the recurrences take place, and local recurrence should now seldom occur if the operation has been properly performed and the case was originally a suitable one for operation.



TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Hospital Cases						
Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
250	1930	M	66	B	R	6 yrs.
251	1930	M	61	B	R	1 yr. Recurrence
252	1930	M	52	B	R	27 yrs.
253	1930	M	50	B	R	27 yrs.
254	1930	M	53	B	R	2 yr. Recurrence
255	1931	M	57	B	D	Sepsis
256	1931	F	43	B	D	2 yrs. Recurrence in liver
257	1931	M	55	B	D	Sepsis
258	1931	F	50	B	R	4 yrs. d.o.c.
259	1931	F	53	B	R	4 yrs. Recurrence in liver
260	1931	M	58	B	R	2 yrs. Recurrence
261	1932	M	56	B	R	3 yrs. Recurrence
262	1932	M	58	B	R	Broncho pneumonia
263	1932	F	48	B	R	15 yrs. (had aortic aneurism at time of operation)
264	1932	M	59	B	D	Pulmonary embolism
265	1932	F	53	B	R	4 yrs. Recurrence
266	1932	F	53	B	R	7 yrs. Recurrence right lung
267	1932	F	54	C	A	2 yr. Recurrence right groin
268	1932	M	60	C	A	4 yrs. Recurrence
269	1932	M	54	B	R	1 yr. Recurrence in liver
270	1932	F	72	B	D	Pneumonia
271	1933	F	74	B	R	2 yr. Recurrence in liver
272	1933	F	66	B	R	9 yrs. Recurrence
273	1933	F	59	B	R	4 yrs. Recurrence
274	1933	F	60	B	R	4 yrs. Recurrence
275	1933	M	60	A	R	13 yrs.
276	1933	M	61	A	R	4 yrs. Recurrence
277	1933	M	63	A	R	0 yrs. d.o.c.
278	1933	F	60	B	A	0 yrs. d.o.c.
279	1933	M	65	A	R	0 yrs. d.o.c.
280	1934	F	56	B	R	5 yrs. Cancer of leg
281	1934	F	58	B	R	13 yrs.
282	1934	F	59	B	R	13 yrs.
283	1934	M	47	A	R	12 yrs.
284	1934	F	53	B	R	12 yrs. Cancer of cervix
285	1934	M	53	A	R	12 yrs.
286	1934	M	60	C	R	Hemorrhage
287	1934	M	49	B	R	12 yrs.
288	1935	M	65	C	R	12 yrs.
289	1935	M	61	A	R	3 yrs. Recurrence
290	1935	M	65	B	R	4 yrs. Recurrence
291	1935	M	64	B	R	2 yrs. Recurrence
292	1935	M	64	B	R	12 yrs.
293	1935	M	58	A	R	12 yrs.
294	1935	M	55	B	R	11 yrs. d.o.c.
295	1935	M	73	C	D	Dilatation stomach
296	1935	M	60	A	R	6 mos. Recurrence in liver
297	1935	M	63	C	R	1 yr. Recurrence
298	1936	M	63	B	R	11 yrs.
299	1936	F	50	B	R	4 m. Recurrence
300	1936	M	50	C	R	1 yr. d.o.c.
301	1936	M	58	B	R	11 yrs.
302	1936	M	50	B	R	7 yrs. d.o.c.
303	1936	F	57	C	R	1 yr. Recurrence in liver
304	1936	M	49	B	R	2 yrs. d.o.c.
305	1936	M	55	C	R	4 yrs. d.o.c.
306	1937	M	58	C	R	7 yrs. d.o.c.
307	1937	M	77	B	D	Sepsis
308	1937	F	70	A	R	0 yrs. d.o.c.
309	1937	M	70	A	R	Sepsis
310	1937	M	6	C	D	Intestinal failure
311	1937	M	57	B	R	2 yrs. Recurrence
312	1937	M	60	A	R	10 yrs.
313	1937	M	51	C	R	2 yrs. Recurrence
314	1937	M	63	C	R	Few mos. later recurrence
315	1937	F	59	B	R	0 yrs.
316	1938	M	65	A	R	0 yrs.
317	1938	F	60	A	R	Untraced since Dec 1936
318	1938	M	60	C	R	Recurrence in few months
319	1938	M	49	A	R	2 yr. d.o.c.
320	1938	M	44	A	R	8 yrs.

TABLE SHOWING RESULTS AND SUBSEQUENT HISTORY OF PATIENTS TREATED BY PERINEAL EXCISION—Continued

Hospital Cases						
Case	Year of operation	Sex	Age	Type of case	Result of operation	Length of survival and remarks
321	1939	M	68	A	R	2 yrs.
322	1939	M	61	C	R	Few mos. later recurrence
323	1939	M	65	C	R	1 yr. d.o.c.
324	1939	M	51	C	R	2 yrs. d.o.c.
325	1939	M	52	B	R	8 yrs.
326	1939	M	50	C	R	1 yr. Recurrence
327	1939	F	64	C	R	Few mos. Recurrence
328	1939	F	53	C	R	1 yr. Recurrence
329	1939	F	53	C	R	Few mos. Recurrence
330	1939	M	68	B	R	8 yrs.
331	1939	M	43	C	R	2 yrs. Secondaries in brain
332	1939	M	53	C	R	5 yrs.
333	1939	F	55	B	R	8 yrs.
334	1939	M	46	C	R	1 yr. Recurrence
335	1939	F	57	B	R	3 yrs. Recurrence in lung
336	1939	M	67	A	R	7 yrs.
337	1939	F	38	C	R	Exhaustion 43rd day
338	1939	F	62	C	R	1 yr. Recurrence
339	1939	M	40	C	R	Few mos. Recurrence
340	1939	F	45	A	R	3 yrs. Recurrence
341	1939	M	60	A	R	7 yrs.
342	1939	M	58	C	R	7 yrs.
343	1939	F	56	B	R	7 yrs.
344	1939	M	60	C	R	4 yrs. d.o.c.
345	1931	M	62	B	R	6 yrs.
346	1931	M	65	B	R	6 yrs.
347	1931	M	61	B	R	6 yrs.
348	1931	M	58	C	R	1 yr. d.o.c.
349	1931	M	40	B	R	6 yrs.
350	1933	M	61	C	R	1 yr. Recurrence
351	1933	M	54	C	R	2 yrs. Recurrence
352	1933	M	56	B	R	5 yrs.
353	1933	F	51	A	R	1 yr. d.o.c.
354	1933	F	51	A	R	2 yrs. Recurrence
355	1933	F	40	C	R	Cardiac failure
356	1933	M	57	B	R	5 yrs.
357	1933	F	49	A	R	4 yrs.
358	1933	M	54	B	R	4 yrs.
359	1933	M	58	B	R	4 yrs.
360	1933	M	64	B	R	4 yrs.
361	1933	F	53	C	R	4 yrs.
362	1933	F	49	B	R	4 yrs.
363	1933	M	71	B	D	Pneumonia
364	1933	M	71	C	R	2 yrs. d.o.c.
365	1933	M	51	B	R	3 yrs.
366	1934	M	53	C	R	3 yrs.
367	1934	M	50	B	R	3 yrs.
368	1934	M	72	C	R	2 yrs.
369	1934	M	64	C	R	3 yrs.
370	1934	M	64	C	R	3 yrs.
371	1934	M	51	C	R	3 yrs. I tracheal secondaries
372	1934	M	61	C	R	Recurrence lung
373	1934	M	52	C	R	2 yrs. ? recurrence
374	1935	F	61	C	R	1 yr.
375	1935	F	63	C	R	Few months recurrence in liver
376	1935	F	72	B	R	Well to date
377	1935	F	66	C	R	Well to date
378	1935	F	66	C	R	Well to date
379	1935	M	39	C	R	Well to date
380	1935	M	70	C	R	Well to date
381	1935	M	70	B	R	Well to date
382	1936	M	50	C	R	Well to date
383	1936	F	66	B	R	Well to date
384	1936	M	62	C	R	Few months. Secondaries in liver
385	1936	M	62	C	R	Well to date
386	1936	M	50	C	R	Well to date
387	1937	F	68	B	R	Well to date
388	1937	F	46	B	R	Well to date

#Villous
\$Squamous

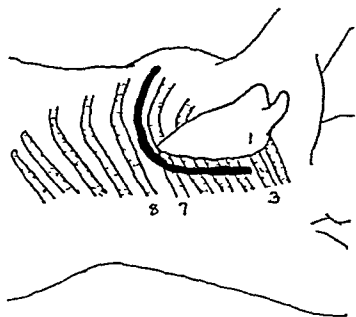


Fig. 1 Incision starts in seventh interspace in mid-clavicular line and is carried posteriorly. It extends upward between the vertebral border of the scapula and the spine. The seventh, sixth, fifth, and fourth ribs are divided as indicated.

For example, the second case of 3 to be described presently, noted a rather sudden intolerance to hot liquids. Swallowing of hot fluid produced a burning sensation retrosternally. It is possible that this may be considered the earliest symptom of carcinoma of the esophagus. Careful analysis of a large series of cases will be necessary to prove this point. In any event, more attention must be paid by the physician to the patient's complaints and more exact methods utilized to establish diagnosis.

Any patient who develops a disturbance of the act of deglutition should be referred immediately to a competent radiologist for x-ray examination. It is possible to miss an early growth of the esophagus with the barium mixture usually employed

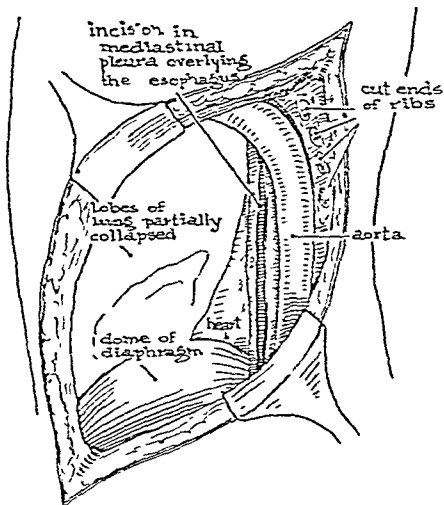


Fig. 2. An incision is made in the mediastinal pleura, exposing the esophagus.

for gastro-intestinal study. I wish to emphasize this point because this is exactly what happened with the second case reported herewith. The initial fluoroscopic and x-ray examinations were negative. The persistent efforts of the radiologist finally disclosed a very small filling defect in the esophageal wall which was visualized with the aid

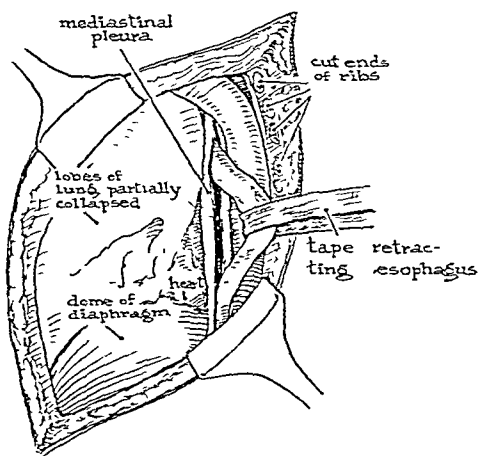


Fig. 3 The esophagus is dissected free from its attachments and a tape is placed around it. Traction on the tape aids materially in the subsequent dissection.

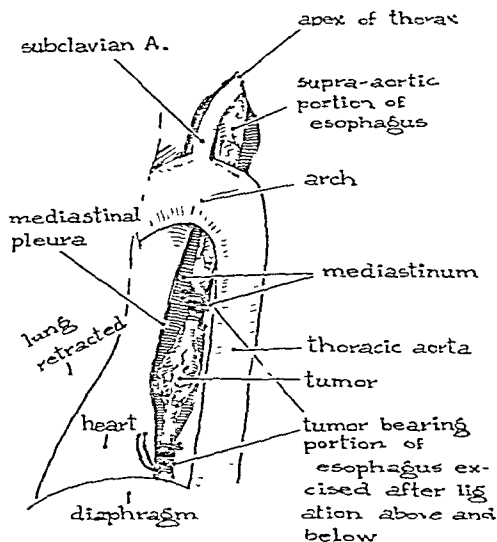


Fig. 4 The mediastinal pleura above the aortic arch is incised and the esophagus is freed from the surrounding structures. The tumor-bearing portion of the organ with a wide margin of normal tissue is removed after double ligation and division.

THE SURGICAL TREATMENT OF CARCINOMA OF THE THORACIC ESOPHAGUS

With a Report of Three Successful Cases

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SINCE Torek's report of the first successful resection of the thoracic esophagus in 1913, progress in the field of esophageal surgery has been slow indeed. The anatomical location of the organ, the technical difficulties often attending the operative procedure, the poor general condition of the patients when first seen by the surgeon, the prohibitive mortality rate which has come to be associated with the operation, all have been factors in retarding the progress of this branch of surgery. In addition, the medical profession has for a long time, regarded x-ray therapy as the only form of treatment for this disease. That this generally accepted view is erroneous is proved by a casual survey of the literature dealing with the late end results of x-ray therapy. The 2 or 3 isolated cases that have been reported to have survived at least 2 years following radiation have in the final analysis no real significance. The most recent report of a large series of cases comes from the Memorial Hospital in New York. The paper was published by Watson in 1936 and includes a group of 666 cases. These Watson divided into 2 series. The second group constituted those most recently treated. In this group, 68 patients were treated by divided doses of x-ray. Of these 33 were alive at the time of his report, 8 for 1 year or more, and 2 for 2 years. In the first series the average length of life was only 4.8 months. When one considers that carcinoma of the esophagus is usually a slow growing tumor, the prolongation of life with radiation therapy may have only relative significance, especially inasmuch as preliminary gastrostomy was performed in almost every case, thus insuring an adequate food intake.

The use of radium applied directly to the carcinoma by means of the esophagoscope has little to commend it. The danger of necrosis of the esophageal wall with perforation and fatal mediastinitis, is too obvious to warrant consideration of this remedy. It can be seen therefore, that radiotherapy holds little promise of complete

eradication of the disease and that serious consideration of this form of treatment for esophageal carcinoma should be reserved for the obviously inoperable cases.

The rapid advances made in recent years in the field of thoracic surgery have given impetus and encouragement to a few surgeons to attempt surgical excision of the thoracic esophagus for carcinoma. That initial attempts have been attended by a high mortality is natural and to be expected. The same has been true in the development of every other surgical procedure of any magnitude. Constant persistence in one's efforts until a mature judgment in the selection of cases suitable for operative intervention has been developed and until the operative technique itself has become standardized and possibly simplified, will, undoubtedly, have the effect of rapidly lowering the mortality rate to a more reasonable level.

Unfortunately, the patient with carcinoma of the esophagus usually comes to the surgeon after the lesion has advanced so far locally as to preclude excision, or when his general condition because of malnutrition and dehydration, is so poor that any surgical procedure would result in a fatality. When one remembers that most of these patients are elderly, and that there may be associated organic disease of other organs, such as myocardial damage, pulmonary disease, nephritis, and arteriosclerosis, it is not surprising that the number of patients that may be submitted to operation is indeed small.

As with carcinoma of other organs, early diagnosis is of the greatest importance. This means that the patient will reach the surgeon in good condition and so be better able to withstand the severity of the operation. A lower mortality will necessarily follow. One should not wait for the effects of starvation and dehydration to become evident before considering surgical intervention. Usually when great weight loss has occurred the condition will probably be found inoperable. One should regard, therefore, changes in the act of swallowing in a person past 40 years of age, with the same suspicion as he does change in bowel habit in the diagnosis of carcinoma of the colon.



Fig 10. Roentgenogram of esophagus following ingestion of barium, showing an irregular stenotic defect between the eighth and tenth dorsal vertebræ. Case 1.

tration of high caloric intake, 1 or 2 transfusions, and the performance of a preliminary permanent gastrostomy, preferably of the Janeway type. Extending the preparatory period over 1 to 3 weeks is time well spent. The patient's general condition may be so greatly improved that he will be able to withstand successfully the severity of the operation. In order to cleanse the ulcerated surface of the neoplasm and possibly thereby diminish considerably the peri-esophageal inflam-



Fig 12. Microscopic section of specimen showing infiltrating squamous cell tumor with epithelial pearl formation. Case 1.



Fig 11. Gross specimen of resected esophagus. Unfortunately, the organ was opened through the neoplasm. Case 1.

mation which often exists, I have recently suggested repeated washing of the esophagus for 3 or 4 days before the operation. A Levin tube is passed to a point just above the neoplasm and through it saline or boric acid solution is irrigated past the growth. The washings descend into the stomach and emerge through the gastrostomy tube. This method of cleansing the surface of the

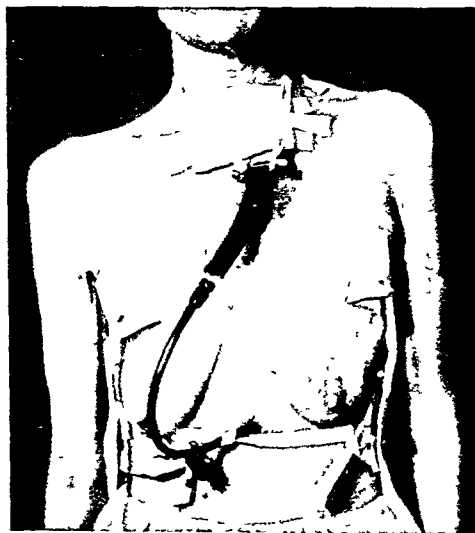


Fig 13. Photograph of patient 4 months after esophagectomy was performed, showing the rubber esophagus in place. Case 1.

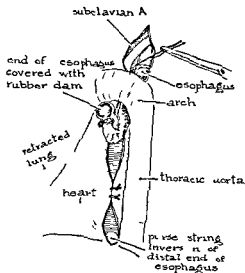


Fig 5 Beginning suture of the mediastinal pleural flaps is shown. The infra aortic remains of the esophagus are brought to lie entirely above the arch.

of a much heavier mixture of barium by the method known as the mucous membrane technique.

It is fair to state, therefore, that a patient past 40 years of age who presents any disturbance in swallowing which persists for longer than 2 or 3 weeks should be submitted for x ray examination by a competent radiologist, who, should the initial findings prove negative, must employ the mucous membrane technique to prove or disprove the results of the first examination. If the symptoms persist despite completely negative findings, a repetition of the examination after a month would be in order. Or better still, esophagoscopy can be

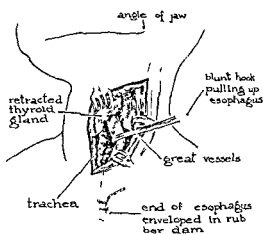


Fig 6 The cervical portion of the esophagus is exposed and the remainder of the organ is drawn out of the chest.

performed. This would definitely establish the diagnosis. If the x ray findings are suggestive of a tumor, the patient must be esophagoscoped by a competent operator. This phase of the examination is most important because the esophagoscopist is able to localize the tumor accurately, note its size, determine the presence or absence of ulceration and the relative fixation of the tumor, and, what is most important, remove a small section for microscopic study.

If a patient's condition is fairly good, and if the findings by x ray and esophagoscopy indicate that the tumor may be operable, then the patient may be prepared for the radical operation. This entails careful attention to mouth hygiene, adminis-

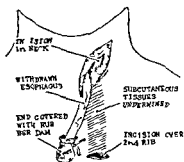


Fig 7

Fig 7 A subcutaneous channel is made extending from the lower end of the cervical incision as far as the second rib.

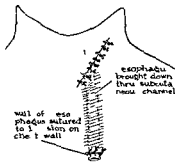


Fig 8

Fig 8 The esophagus is drawn through the channel and

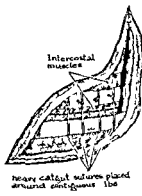


Fig 9

its end is sutured to the transverse skin incision as shown. Fig 9 The thoracic wound is closed by enclaving the contiguous seventh and eighth ribs with heavy catgut sutures.

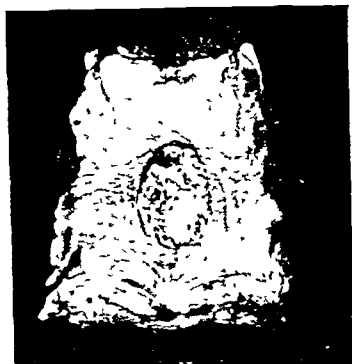


Fig 15. Gross specimen showing the very early lesion. This photograph indicates the extent of contraction of the resected organ. The specimen was about twice as long when first removed. Case 2.



Fig 16. Microscopic section showing squamous cell carcinoma with pearl formation. The absence of infiltration beyond the mucosa is noteworthy. Case 2.

A vertical incision is made in the mediastinal pleura from the under surface of the aortic arch down to the diaphragm (Fig. 2). The pleural edges are dissected away from the underlying esophagus so as to form two flaps. These should be carefully preserved because they must be used later on in the operation to close the mediastinum. It is not difficult to free the esophagus bluntly throughout its circumference at one point. A tape is placed around the organ at this site and traction permits the surgeon to free the esophagus throughout its extent (Fig. 3). It is important to ligate the small esophageal arteries rising from the aorta and to divide the small branches of the vagus nerves. If care is exercised in ligating all small vessels, there will be surprisingly little loss of blood. This is important.

Unless the neoplasm is hopelessly attached to the aorta, the operation should be continued. Not infrequently, the tumor may be fixed to the mediastinal pleura on the right side. Our first case presented this complication. It was found necessary to excise a piece of the right pleura along with the tumor in order to effect a radical removal. This resulted in a bilateral pneumothorax, but the effect on the patient was barely discernible. The opening in the pleura was packed and later closed with a running stitch of catgut. During the course of the operation, probably every 10 or 15 minutes, it is advisable to remove all packings and retractors, close the gaping wound and have the anesthetist expand the lung by increasing the pressure in his apparatus. Any circulatory or respiratory depression that may have occurred is immediately overcome.

An incision is made in the mediastinal pleura above the arch of the aorta and is extended as far

as the apex of the thorax (Fig. 4). Pleural flaps are fashioned here also and the underlying esophagus is freed from its surrounding attachments by careful finger dissection. The most shocking part of the operation occurs when the esophagus is separated from the posterior surface of the aortic arch. This maneuver must be executed with great care and with as little trauma as possible. The next step consists of division of the esophagus with the carbolic acid cautery between heavy silk ligatures about 1 inch above the diaphragm. The distal end is inverted into the stomach with two pursestring sutures of silk. This may be reinforced by a layer of mattress sutures of chromic catgut. The esophagus is again divided between heavy silk ligatures above the neoplasm, and the tumor-bearing portion is removed (Fig. 4). This, I believe, is an important modification of the original Torek technique. Removal of the tumor immediately eliminates the infected portion of the esophagus and decreases greatly the possibility of spillage and contamination of the pleural cavity. It also obviates dragging the tumor-bearing area through the thoracic aperture into the neck wound. It was at this point that the ligature slipped off the end of the esophagus in our first case and permitted contamination of the pleura with the highly infected fluid present in the ulcerated surface of the carcinoma. An almost fatal empyema soon followed. It was because of this accident that the technique was changed as described.

The remaining segment of the esophagus is brought to a position above the aortic arch by means of a curved clamp placed from above downward behind the arch and grasping the ligature



Fig. 14. Roentgenogram following ingestion of heavy mixture of barium. This shows a small filling defect in the esophageal wall. Case 2.

carcinoma which is usually infected should materially decrease the incidence of postoperative mediastinitis.

During the 7 to 10 days following the gastrotomy, considerable improvement may be noted. The patient should be given about 6 ounces of high caloric fluid food through the gastrotomy tube every 3 hours. The necessary vitamins and minerals must be included in these feedings. The patient should be encouraged to take additional food by mouth because it has been found that the admixture of saliva is beneficial. Often, it is wise to transfuse the patient before operation. A transfusion during or immediately after the operation is imperative. This helps materially in combating operative shock.

Anesthesia. The combination of avertin and ethylene gas anesthesia seems to be an ideal one. Ethylene is the least irritating of all the inhalation anesthetics, and causes little or no circulatory depression. The only objection to its use is that the actual cautery cannot be used to divide the esophagus during the operation. But its many advantages far outweigh this minor inconvenience. The combination of avertin and ethylene was very satisfactory in the 3 cases reported here with it. It is important that the services of a competent anesthetist be obtained. The anesthetic

must be administered under varying degrees of positive pressure during the operation to vary the extent of inflation of the lung. I am convinced the recovery of our 3 patients was in no small measure due to expertly administered anesthesia.

OPERATION

The operative technique to be described is a modification of the operation developed by Torek and reported by him in 1913. The operation is more tedious than difficult. The steps of the procedure should be carried out methodically without haste. It is important to avoid unnecessary bleeding and to prevent infiltration of the mediastinum with blood. This requires careful hemostasis. The lobes of the lung should be handled as gently as possible and care should be exercised not to traumatize the arch and descending portion of the aorta. These precautions will have the effect of greatly decreasing the operative shock.

The patient is placed on his right side with the head resting on the abducted right arm and his back close to the edge of the operating table. The left arm is elevated and wrapped in sterile towels after preparation and placed in the care of a sterile nurse. One or two sandbags placed against the anterior chest region will prevent the patient from rolling forward on the operating table. After the usual skin preparation the patient is draped in such a way as to leave exposed the chest, upper abdomen, left shoulder and arm and neck.

The incision begins in the seventh interspace in the mid clavicular line and is continued posteriorly along the course of the seventh interspace (Fig. 1). It is then carried upward between the vertebral border of the scapula and the spine as far as the third rib. The thoracic musculature is divided in the line of the skin incision. All bleeding points are carefully ligated before the thoracic cavity is entered. An incision is made in the seventh interspace dividing the parietal pleura with the intercostal muscles. The seventh, sixth, fifth and fourth ribs are quickly divided about 1 inch from the spine and the intercostal vessels are ligated with hemostatic sutures. A rib spreader is inserted thus affording a clear view of the left thoracic cavity. The lobes of the lung usually collapse when the chest is opened but complete collapse should not be permitted to take place because of possible circulatory embarrassment. The extent of collapse can be controlled by the anesthetist. The arch and descending aorta stand out in sharp relief. The esophagus which lies to the right of the aorta in the mediastinum can neither be felt nor seen. It may be possible to palpate the carcinoma.



Fig 23 Side view showing the close approximation of the tube to the skin surface.

which makes for added precaution against contamination (Fig. 6). A subcutaneous channel $1\frac{1}{2}$ inches in width is made extending from the lower end of the neck incision down to a point on the left side opposite the second rib (Fig. 7). A transverse incision $1\frac{1}{2}$ inches in length is made at this site and the esophagus is drawn through this tunnel. The esophagus is sutured to the skin incision with interrupted silk stitches. The cervical incision is closed and a dressing is applied (Fig. 8).

Finally, the patient is turned again on his right side. Here also care must be exercised to maintain asepsis. Gowns and gloves are again changed and clean instruments are utilized for the final steps. The chest wound is reopened and the mediastinum is inspected. All blood clots are removed and overlooked bleeding points ligated. The mediastinum both below and above the arch of the aorta is closed by suturing the two flaps of mediastinal pleura with a running stitch of catgut (Fig. 5). I believe it is important to drain the thoracic cavity in every case. Many intrathoracic complications may develop and it is a comfort to have a vent for at least the first 3 or 4 days after operation. For this purpose, a stab wound is made posteriorly in one of the lower intercostal spaces and a medium sized soft rubber tube is inserted for 2 or 3 inches. This should be fastened to the chest wall by means of a suture passed

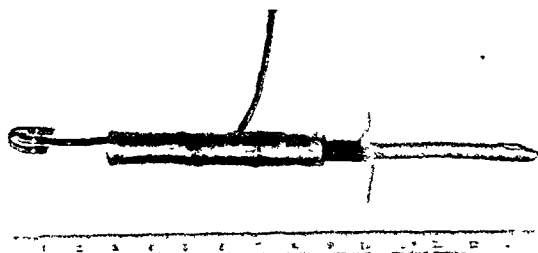


Fig 24. Photograph of tube devised for patient by Dr Margolin. The small side vent allows for the escape of swallowed air. There is no leakage at any time. Case 2.

through a cuff. When the patient is returned to bed, the outer end of the intercostal tubing should be placed under water in a bottle beside the bed, insuring a closed system.

The thoracic wound is now ready for closure. The ribs are approximated by passing heavy chromic gut sutures around the seventh and eighth ribs (Fig. 9). The parietal pleura and intercostal musculature are closed together with a running stitch of catgut. Previous to this step, the lobes of the lung should be inflated by the anesthetist. The divided thoracic musculature is next repaired with interrupted sutures of plain catgut and the skin is closed in the usual way. After the dressing is applied, the anesthetist should again inflate the lungs until air bubbles no longer appear at the outer end of the intercostal tube which has been placed in a basin of water.

Postoperative care. When the patient is returned to bed, he should be placed in a semirecumbent position. The Gatch bed is ideal for this purpose. Measures should be instituted to combat shock. Although hypodermic medication, stimulating enemas, external heat, etc., have undoubted value, the most effective remedy is a transfusion of whole blood. Sufficient morphine should be given to relieve pain. During the first 3 or 4 days, fluids should be given by clysis or, preferably, by the continuous intravenous drip method. Five per cent glucose in saline solution makes an ideal combination. If the inversion of the esophageal stump into the stomach has been satisfactory, fluid may be given by the gastrostomy tube. If the inversion has not been quite satisfactory, it is wise to delay gastrostomy feeding until the sixth or seventh day. Regular feedings should be given as soon as the general condition of the patient permits.

The care of the esophageal stump is important. Beginning the second day the patient should be encouraged to swallow fluids, which must be caught in a basin. This cleanses the esophagus



Fig 17

Fig 17 Photograph of patient 3 months after esophagectomy showing the fistula above and the gastrostomy opening. Case 2



Fig 18

Fig 18 Posterior view showing healed incisions

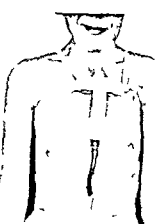


Fig 19

Fig 19 Front view showing the rubber esophagus in place

surrounding the cut end of the organ (Fig 5). It will be noted in the drawing that the end of the esophagus has been protected with an envelope of rubber dam in order to minimize contamination. Warm packs are placed in the mediastinum, all other packings and string pads and retractors are removed, and the wound is temporarily closed with a few through and through sutures.

The patient is now turned on his back. In doing so, great care must be exercised to maintain asepsis. The neck and anterior chest region are exposed and prepared. A complete clean instru-

ment tray should be at hand for this stage. Gowns and gloves should be changed. An incision is made along the anterior edge of the left sternocleidomastoid muscle. The latter structure and the great vessels are retracted externally. The lateral thyroid vein is ligated and divided and the thyroid lobe is retracted medially (Fig 6). The cervical portion of the esophagus is easily identified and dissected free. A blunt hook is placed beneath it and traction draws the remaining portion out of the thoracic cavity. This is another modification of the Torek technique.



Fig 20

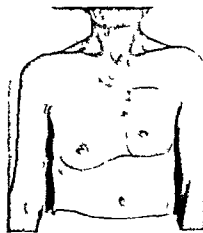


Fig 21

Fig 20 Side view showing position of rubber esophagus
Fig 21 After partial antethoracic esophagoplasty. The skin lined tube ends at level of xiphoid cartilage

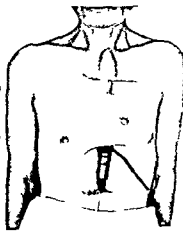


Fig 22

Fig 22 Showing the rubber esophagus tube in place. The short side tube acts as a vent for the escape of swallowed air



Fig 28 Photograph of patient taken 2 weeks after operation Case 3



Fig 29 Anterior view showing the healed cervical incision and the esophageal fistula opposite the second rib. Case 3

charge from the hospital is chiefly that of experimenting with various sizes of rubber tubing until the rubber esophagus fits snugly into the fistula above. Leakage of ingested fluid from the upper end may be obviated by having the patient compress the orifice against the rubber tubing. Due to the fact that the ability to belch gas has been removed by the operation, mechanical disturbances may develop which become distressing to the patient. For instance, our second patient could not eat without swallowing considerable air. It soon became evident that a column of air formed in the rubber esophagus, gradually rising to a higher level as the patient continued eating. Finally, a reservoir of air collected in the remains of the esophagus above the fistula. A violent contraction of the esophageal stump forced the air and considerable fluid food out of the fistula around the tube and no amount of finger pressure could overcome this tendency. The constant soiling at meal time became very distressing to the patient. In order to overcome this, a partial antethoracic esophagoplasty was performed about 8 months after her original resection, forming a skin-lined tube continuous with the upper esophageal stump and ending at a point opposite the lower sternum (Figs 21, 22, and 23). Food is now conveyed the remainder of the distance to the stomach by a removable rubber tube (Fig 24). At the present time, there is no leakage whatsoever from the lower end of the skin-lined esophagus.

The suggestion has been made that the newly formed skin-lined esophagus be extended by another plastic operation so that it becomes con-

tinuous with the gastrostomy opening, thus obviating the use of any tube. This should not be difficult from the technical standpoint. However, the experiences of Eggers and others with this procedure indicate that the reflux of gastric juice into the skin-lined esophagus, causes digestion of the epithelium with the formation of ulcers and fistulas. For this reason and because the patient has no inconvenience from the use of the short rubber tube, we have not completed the esophagoplasty beyond its present stage. The use of a loop of small or large bowel placed subcutaneously to restore esophageal continuity involves an operation of too great magnitude and risk to warrant serious consideration in the type of case under discussion. If the object of our original operation, namely, eradication of the malignant growth, has been attained, little will be accomplished by attempting difficult procedures to restore esophageal continuity, especially if the patient is comfortable with a removable rubber esophagus.

Up to the present writing, there have been reported 6 successful resections of the thoracic esophagus for carcinoma. The cases reported in this paper constitute the seventh, eighth, and ninth. Undoubtedly other attempts have been made, but these have not appeared in the literature probably because of the fact that the patients died after operation. Despite this small number of successful recoveries, I am convinced that the operation should be undertaken more often and that the incidence of operability can be greatly extended. The operation need not be followed by a prohibitive mortality if the preoperative preparation is carefully done and if the



Fig 25. X-ray of esophagus following ingestion of barium showing an almost complete occlusion beginning at the ninth dorsal vertebra. Case 3

and helps to restore the act of deglutition. It is important to maintain good mouth hygiene and toward this end, patients should be encouraged to chew gum.

The intrathoracic situation must be watched closely and will usually give the surgeon concern during the first week. Some indication of what is



Fig 26. Gross specimen showing neoplasm completely encircling the esophagus. Case 3

going on within the chest may be obtained by the temperature, the pulse rate, physical signs, x-ray examination of the chest, and the amount and character of the drainage through the intercostal tube. If there is no dyspnea if the temperature, pulse, and physical signs are within normal limits and if the drainage becomes less and less each day, the tube may be removed permanently. If x-ray examination and the clinical course indicate the presence of an empyema, surgical drainage will be indicated. It is important not to delay this step too long because these patients, in view of their precarious condition, cannot stand infection for very long.

As soon as the patient's condition warrants it, usually about the third week, the continuity of the esophagus should be established by inserting a rubber tube into the upper fistula and connecting it with the gastrostomy tube (Figs 13 and 19). The tube is held in place by carrying a tape around the patient's neck and attaching it to a safety pin which is inserted transversely into a rubber cuff placed about the tube about 2 inches below its upper end. The patient is now encouraged to take all nourishment by mouth. In order to swallow solid food, he must thoroughly masticate it and mix it with more fluid than the normal person so that it will descend more easily through the tube into the stomach. From the experience with our 3 cases, I am convinced that the admixture of saliva is important for the well being of the patient. From the moment that eating by the usual route was commenced, these patients began to improve rapidly and gained weight. It is hardly necessary to add that the rubber esophagus should be removed frequently and cleansed.

The care of the patient subsequent to his dis-

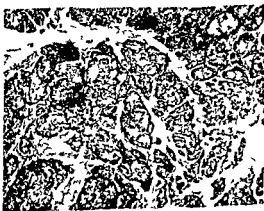


Fig 27. Microscopic section showing infiltrating squamous cell carcinoma. Case 3

postoperative day. On this day also, the rubber esophagus was inserted and the patient began taking most of her feedings by mouth (Fig. 13).

During the following 2 months, the patient continued to improve slowly. All feedings were being taken by mouth. A regular schedule for these feedings had been prepared for the patient and it was assumed that she was following the directions implicitly. The empyema cavity gradually contracted down and was represented by a narrow cleft extending toward the upper portion of the pleural cavity for a distance of about 6 inches. The lining of this cavity became rigid, and it was felt that surgical closure at some future date would be necessary.

Around the beginning of August, which was approximately 3 months after the original esophageal resection, the patient began to develop edema of the legs and feet, irregular reddish-brown skin lesions on the dorsum of the hands, a beefy-red tongue, and gastro-intestinal symptoms consisting of bouts of diarrhea and abdominal cramps. Upon closer questioning, it was found that the patient had been taking nothing but clear broths for a period of 3 weeks. She presented the picture usually associated with pellagra. When placed upon an adequate intake of protein, concentrated vitamins, fats, carbohydrates, and minerals, these symptoms disappeared. The lesions on the dorsum of the hands were no longer noticeable after 2 weeks of treatment. The patient began to recover her lost weight and gained an average of 3 pounds a week.

About the middle of November, 1936, approximately 6 months after esophagectomy, there was noted a small swelling mesial to the cervical scar and just above the inner end of the left clavicle. This lump appeared to be quite superficial and measured about an inch in diameter. It was firm and not tender. Through a small incision, a biopsy specimen was taken which showed the same histological characteristics as the original esophageal growth. This may very well represent an implantation carcinoma, the implantation occurring at the time of the original operation when the ligature slipped off the distal end of the cut esophagus and gross spilling occurred. I do not believe that this represents a metastasis or an extension along lymphatic channels because the tumor was attached to the skin, was not situated in the anatomical location of lymph nodes, and was not part of the wall of the esophagus. The mass was treated intensively with x-ray and apparently completely disappeared during the following 6 weeks. Up to the present time there has been no recurrence at this site.

Since then, repeated check-up roentgenograms were taken of the chest and the long bones for possible metastases. These have been consistently negative.

In May of 1937, 13 months after the original esophagectomy, the patient was admitted again to the hospital for operative closure of the chronic empyema cavity. This was accomplished in 2 stages which consisted of removal of the ribs overlying the cavity, thus permitting the overlying soft parts to fall in so as to obliterate it.

At the present writing, 18 months after esophagectomy, the patient is slowly regaining the weight which she lost during her stay in the hospital. She is taking all her food by mouth and utilizes the rubber esophagus. She has no difficulty with her makeshift swallowing mechanism and takes care of the cleaning and manipulation of the tubing herself.

CASE 2. Mrs. H. M., aged 53 years. This patient was first seen on November 2, 1936. She presented the following history: Eight weeks before she noted an uncomfortable sensation behind the lower sternum when she swallowed warm liquids. She described it as being similar to the sensation following the swallowing of a fish bone. This discomfort persisted and was noted only at meal time when drinking hot liquids. A few weeks later she noted that solid

foods produced the same discomfort. She was referred for x-ray studies on October 17, 1936, exactly 6 weeks after the onset of symptoms. Films taken by the ordinary technique failed to disclose any esophageal abnormality. Dr. Bendick repeated his examination and was able to demonstrate a small irregularity in the esophagus only after he employed a heavier mixture of barium (Fig. 14). The findings indicated a small tumor mass measuring about an inch in diameter situated approximately 3 inches above the cardia. There was no obstruction to the passage of the barium. He ventured the opinion that this tumor was probably malignant. One week later esophagoscopy was performed by Dr. Kramer, who found a small sessile growth situated in the lower esophagus 34 centimeters from the incisor teeth. The surface of the tumor did not appear ulcerated. A biopsy specimen revealed squamous cell carcinoma. Past, family, and personal histories were irrelevant except for the fact that a cousin died of carcinoma.

Physical examination was completely negative. The heart and lungs were negative. Blood pressure: systolic 140, diastolic 85. The situation was discussed freely with the patient who possessed more than average intelligence, and radical surgical excision of the esophagus was offered as the only definite method of curing her of her condition. She finally elected to undergo the operation.

She was admitted to the Mt. Sinai Hospital on November 14, 1936. Preliminary studies showed a normal urine; hemoglobin, 75 per cent; red blood cells, 4,650,000; white blood cells, 7,000; polynuclear leucocytes, 57 per cent; monocytes, 1 per cent, lymphocytes, 42 per cent. Wassermann was negative.

On November 16, a Janeway gastrostomy was performed under avertin, gas-oxygen anesthesia. Her convalescence following this procedure was uneventful. Feedings through the catheter were started on the second postoperative day.

Resection of the esophagus was performed on November 28, under avertin, ethylene anesthesia. The technique of this operation is described in the text. After the esophagus had been mobilized, a small tumor was felt in the right lateral wall about 3 inches above the diaphragm. Considerable difficulty was encountered in inverting the stump of the esophagus into the stomach, due, first, to the depth of the opening, second, the short esophageal stump, and third, because of the wide excursion of the diaphragm during respiration. The ligature around the distal end slipped off, but there was no soiling. It was possible to invert the esophageal end with 4 Lembert stitches of chromic catgut.

The patient's pulse during the course of the operation, which consumed 2½ hours, varied between 88 and 98. The breathing was regular. A continuous intravenous drip of 5 per cent glucose in saline was started during the middle of the operation. More as a prophylactic measure, a transfusion of 500 cubic centimeters was given about an hour after the operation.

Examination of the specimen. Specimen consists of a resected portion of the esophagus, 6 centimeters in length (Fig. 15). The adventitia of the esophagus appears to be covered with a layer of muscular tissue which shows no external evidence of any tumor invasion. Within the center of the specimen is a small, somewhat soft mass which, after the esophagus is opened, is disclosed to be a flat sessile tumor mass situated approximately 2 centimeters from either end of the specimen. This mass is 2 centimeters long, 14 millimeters wide, and is elevated from the surface of the mucous membrane about 1-centimeter. The mass is attached by a broad base to the mucous membrane of the esophagus. It is light pinkish gray in color, and has a number of small surface depressions. Microscopic examination shows a hornifying squamous cell carcinoma with epithelial pearls. There is no infiltration beyond the mu-

operation is performed with due consideration of the need for careful hemostasis, the avoidance of rough handling of the thoracic structures, and the necessity of preventing contamination of the pleural cavity. The 3 cases reported herewith constitute 3 attempts at surgical excision of the thoracic esophagus for carcinoma with no operative mortality.

CASE REPORTS

CASE 1. Mrs B. B., aged 48 years. Was first seen on April 11, 1936. She presented the following history: Six months before admission to the hospital, she noted substernal pain, shooting in character, which radiated from the upper epigastric region toward the throat and occurred 4 to 6 times daily. This was not related to her meals. In the last 4 months she experienced a continuous dull burning sensation in the lower chest anteriorly and also, posteriorly near the spine. During this period there was increasing difficulty in the swallowing of solid food. For the last 2 months she subsisted only on fluids and some solid food. She lost 12 pounds in the last 3 months. The past family and personal histories were irrelevant.

Examination showed a well developed and fairly well nourished woman weighing 141 pound. Blood pressure systolic 110, diastolic 90. Patient had no teeth. Gums were in good condition. Heart and lungs were negative. Peripheral vessels were thickened. X-ray examination by the usual technique disclosed a stenotic lesion about 2½ inches in length in the middle third of the esophagus extending from level of eighth to tenth dorsal vertebrae. The margins of this lesion were irregular and the lumen of the esophagus was displaced anteriorly (Fig. 10).

The patient was admitted to the Mt. Sinai Hospital on April 12, 1936. Laboratory examinations: Wassermann negative, urine negative, hemoglobin 84 per cent, red blood cells 4,850,000, white blood cells 9,000, polymorphonuclear leukocytes 65 per cent, lymphocytes 32 per cent, monocytes 3 per cent. Esophagoscopy by Dr R. Kramer showed an ulcerated granular neoplasm beginning on the posterior wall of the esophagus 30 centimeters from the region of the upper incisor teeth. A biopsy specimen revealed a horrifying infiltrating squamous cell carcinoma.

On April 20, 1936, a Jareway gas trotomy was done through a small left upper rectus incision. The wound healed by primary union. Feedings through the tube were started on the second postoperative day. They were given every 2 hours at first; the interval between feedings was gradually increased to every 4 hours.

Nine days later radical resection of the esophagus was performed following the original Torek technique. After ethylene anesthesia was used. Palpation revealed a thickening in the esophagus about 3 inches below the arch of the aorta. The tumor did not seem to be fixed to the aorta. After the esophagus had been freed the carcinoma was seen to be fusiform in shape and measured about 3 inches in length. Because of its intimate attachment to the mediastinal pleura on the right side, it was found necessary to remove a small piece of the right mediastinal pleura, thus producing a bilateral pneumothorax. This caused little change in the patient's condition. As the esophagus was being drawn out of the chest into the neck wound, the silk ligature at the distal end of the esophagus slipped off, with the escape of a considerable quantity of esophageal contents. From the subsequent course the thoracic cavity was contaminated at the same time. During the course of the operation the patient received a transfusion of 500 cubic centimeters by the citrate method.

Examination of specimen. The specimen consists of a portion of the esophagus measuring 9.5 by 2 centimeters (Fig. 11). The external aspect is distinctly roughened, dull pinkish in color, and shows the presence of numerous fine adhesions. On one side near the center are seen a cluster of 3 lymph glands, the largest about 1 centimeter in diameter, the others 0.7 centimeter. These nodes are soft and elastic. On section there is seen a small grayish white area in the periphery of one of them. On opening the specimen the mucous membrane is seen to be smooth and glistening, pale grayish pink in color and freely movable except over the tumor growth. Two centimeters from the proximal portion of the specimen is an elevation in the mucous membrane 1 centimeter above the surface, which appears somewhat soft and over which the mucosa is not movable. This portion had been opened before receipt of the specimen and is seen to consist of grayish pink strands of tissue, having a finely granular appearance and suggesting an infiltrating neoplasm. On the wall opposite this area is a similar infiltrating mass with the same characteristics. Extending distally from each of these nodules for a distance of 3 centimeters and lying on the surface of the muscularis are 2 irregular areas containing an ulcer base which is covered by yellowish green slough in places and in other situations by finely granular tumor tissue. The border of these ulcerated areas are firm and inelastic. The lumen of the esophagus over the site of the neoplasm is distinctly narrow, measuring 2.5 centimeters when opened in comparison with 5 centimeters in the uninvolved esophagus. Microscopic examination reveals an infiltrating, hornifying squamous cell carcinoma with epithelial pearl formation. One lymph node shows early metastasis (Fig. 12).

Postoperative course. First day: Temperature 104° to 102° degrees Fahrenheit. General condition was good. Air bubbles and several ounces of bloody fluid drained through the thoracotomy tube.

Second day: Temperature 103° degrees Fahrenheit, pulse 128. No dyspnea was noted. Straw-colored fluid drained from the left pleural cavity.

Third day: Temperature was 104° degrees Fahrenheit. Patient was slightly dyspneic and restless. The heart was not displaced to the right. Percussion 100% tympanic posteriorly on the left side. Red blood cells numbered 2,000,000, hemoglobin 43 per cent, white blood cells 20,800, polymorphonuclear leukocytes 80 per cent.

Fourth day: Transfusion of 500 cubic centimeters was given by the citrate method.

Seventh day: Under local anesthesia an incision was made over the left ninth rib posteriorly and a portion of the rib was resected. A small walled-off empyema cavity containing grayish turbid fluid smelling foul was found. The cavity was packed with iodoform gauze. Following this procedure the temperature dropped to a lower level. It varied between 101° to 100° degrees Fahrenheit. X-ray examination of the chest revealed a large encapsulated collection of fluid and air in the left upper chest extending from the apex to the seventh rib posteriorly.

Accordingly another operation was done on the seventh postoperative day. The upper end of the original operative incision was reopened. The sixth and fifth ribs were found exposed. Parts of the sixth fifth and fourth ribs were excised, unroofing a large collection of foul smelling pus and air which was supra-apical in location. The surface of this empyema cavity was lined with a spongy grayish membrane. The cavity was packed with iodoform gauze and the wound was left wide open.

Following this procedure, the patient's convalescence proceeded rapidly. The temperature dropped to normal and her general condition improved. Another transfusion of 500 cubic centimeters was given on the twenty-seventh

were approximated with sutures of fine chromic catgut. A second layer of sutures approximated the subcutaneous tissues over the skin sutures. The remaining skin edges on the chest wall were now undermined extensively on each side. They were then sutured together with ease in front of the newly formed tube. The esophageal fistula was now circumscribed by an incision which left attached to the mucous membrane a small rim of skin. The anterior and lateral borders of the esophageal stump were now sutured to the upper end of the newly formed skin tube. The remaining skin above was then sutured to the upper edges of the lateral chest flap on each side. It was necessary to make two small relaxing incisions on each side of the chest wall at the lower end of the lateral flaps in order to relieve tension.

Convalescence following this procedure was uneventful. The wounds healed by primary union and the patient was discharged on the twelfth day. In the meantime, gastrostomy feedings were being continued. Since then the patient has utilized an ingenious short rubber esophagus devised by Dr. Margolin to bridge the short distance between the lower end of the newly formed esophagus and the gastrostomy (Figs 21, 22, 23 and 24). It will be noted in the photographs that the tube bears a small side vent in the form of a catheter which extends upward into the esophagus and permits escape of swallowed air, but no food. The patient now eats normally without discomfort or leakage.

At the present writing, it is 11½ months since esophagectomy. The patient is approaching her original weight and has returned to her profession of teaching school.

CASE 3. History No 413618. J. T., aged 49 years, was admitted to the Mt. Sinai Hospital on September 3, 1937, presenting the following history. Five weeks ago the patient began to experience difficulty in swallowing solid foods. He noted a sensation of obstruction at about the level of the ensiform cartilage, and, while eating, he felt the food slowly passing the site of obstruction. This passing was accompanied by heartburn. These symptoms rapidly became worse during the succeeding 2 or 3 weeks. He noted gurgling sounds beneath the ensiform cartilage while swallowing liquids. About 2 weeks before admission he began to regurgitate small quantities of food immediately after the ingestion of his meals. The patient lost 20 pounds in weight, and became progressively weaker. There was no back pain.

Personal history. The patient was a painter of structural steel and had worked on ship and subway construction. His habits were regular, and, aside from occasional indulgence in alcohol, the patient had never been given to excesses of any sort. His average weight when well was 155 pounds. His weight on admission was 135. The past history was irrelevant.

Examination showed a well developed, well nourished, middle-aged man who presented considerable difficulty in swallowing fluids and solids. There were no enlarged lymph-nodes. The heart and lungs were negative. Blood pressure was systolic 125, diastolic 80.

Laboratory examinations. Gastric contents were negative for blood. Hemoglobin 86 per cent, red blood cells, 4,800,000, white blood cells, 10,700, polynuclear leucocytes, 57 per cent, lymphocytes, 35 per cent, monocytes, 7; eosinophiles, 1 per cent. Stool was brown, formed, and negative for blood. Urine was negative. Urea nitrogen was 5 milligrams.

X-ray examination by the usual technique disclosed an almost completely obstructing lesion in the esophagus beginning at the upper border of the ninth thoracic vertebra. A small trickle of barium passed by the obstruction into the stomach (Fig 25).

Esophagoscopy was performed on September 9, 1937, and

disclosed a fungating mass occluding the esophagus a distance of 35 centimeters from the upper incisor teeth. A biopsy specimen revealed a hornifying squamous cell carcinoma.

On September 13, 1937, a Janeway gastrostomy was performed through a small left upper rectus incision. The wound healed by primary union. Feedings through the tube were instituted on the second postoperative day.

Three days later, cleansing irrigations of the surface of the carcinoma were instituted, as described in the text. Under fluoroscopic control, a Levin tube was passed to a point just above the obstruction and saline solution was flushed past the growth, the washings emerging from the gastrostomy tube. This was repeated twice daily up to the day of the radical operation.

Seven days later, resection of the esophagus was performed under avertin-ethylene anaesthesia. The technical features are described in the text. Palpation of the mediastinum revealed a thickening beginning about 2 inches below the arch of the aorta and extending downward for another inch. This indicated the site of the carcinoma which seemed fairly well fixed to the surrounding tissues. After mobilization of the esophagus below the growth, it was found that the tumor was intimately adherent to the right mediastinal pleura. However, it was possible to find a plane of cleavage and the esophagus at the site of the tumor was freed without entering the right pleural cavity. The tumor-bearing area with a wide margin of normal tissue was excised between ligatures of heavy silk. In drawing the infra-aortic portion of the esophagus upward behind the arch, the ligature closing off its divided end slipped off, but no visible spilling occurred. The ligature was reapplied and the operation proceeded without further incident.

The patient's pulse during the operation, which consumed 2 hours and 20 minutes, varied between 88 and 106. The breathing was regular. A continuous intravenous drip of 5 per cent glucose in saline was started during the operation. A transfusion of 500 cubic centimeters was given at its termination.

Examination of the specimen. Specimen consists of a portion of resected esophagus measuring 7 centimeters in length (Fig 26). The serosal surface is reddish pink, shows the presence of many adhesions, and has a firm yellowish white and pink nodular area near one end. In this same region there can be felt within the wall a firm, slightly irregular mass which completely encircles the wall of the esophagus. On opening the esophagus there is seen to be present, 15 centimeters from the distal end, a somewhat raised irregularly outlined 2-centimeter mass completely encircling the lumen and showing a shallow ulceration at its center. It appears to extend below the mucosa at its periphery. Both above and below the tumor mass there are present several discrete, firm yellowish nodules several millimeters in size within the mucosa. On section the muscularis shows definite infiltration with grayish granular tumor tissue. Microscopic examination shows an infiltrating squamous cell carcinoma with metastatic involvement of one adjacent lymph node (Fig 27).

Postoperative course. **First day.** Patient's general condition good. The pulse varied between 108 and 124; respiration, 28 to 32. The temperature reached 106.6 degrees Fahrenheit on the evening of this day. The patient's general condition, however, did not suggest any serious difficulty.

Second day. Temperature dropped during 12 hours to 100.2 degrees Fahrenheit. The sharp temperature rise of the preceding day was thought to be due, in part, to a post-transfusion reaction. Four ounces of serosanguineous fluid drained through the intercostal tube. No respiratory diffi-

cous membrane. The muscle layer of the esophagus is free of tumor tissue (Fig 16).

Postoperative course First day. No cyanosis or dyspnea, few complaints. The esophageal stump was inspected and found viable. Patient was able to swallow water without difficulty. The gastrostomy tube was opened every half hour to decompress the stomach and take the tension off the suture line at the cardiac end. Blood tinged serum was draining from the thoracotomy tube. Continuous intravenous drip was maintained.

Second day. No drainage came through the thoracotomy tube. Evident pneumothorax was present on the left side but there was no displacement of the heart. No respiratory difficulty was noted. Temperature was 101 degrees, pulse 90.

Third day. Greenish colored clear fluid in small amounts drained through the thoracotomy tube. Test for bile was negative. Temperature was 101 degrees, pulse 92. The general condition was excellent. Portable x ray of the chest showed some fluid at the left base. There was no evidence whatever of pneumothorax and practically no cardiac displacement. All fluid was given by vein in order to avoid risk of separation of the suture line at the cardiac end of the stomach.

Fourth day. Hemoglobin 70 per cent, red blood cells 4,560,000, white blood cells 24,000, polynuclear leucocytes 87 per cent, monocytes 3 per cent, lymphocytes 10 per cent. Patient showed marked resistance to all forms of hypnotics. In order to obtain rest patient was given a basal dose of avertin by rectum, i.e., 70 milligrams per kilogram and she slept 7 hours.

Fifth day. Patient was considerably improved as a result of rest induced by avertin anesthesia. Her general condition was excellent, pulse 96, temperature 101.8 degrees, respiration 24 to 30. Patient was washing fluids through esophageal stump. The redundant portion of this stump was excised. Examination of the chest fluid was negative for bile. There were scattered white blood cells. Portable x ray of the chest showed an increased amount of fluid in the left pleural cavity.

Sixth day. Patient appears to be a little more dyspneic, no cyanosis, not much change in pulse and respirations. Both operative wounds have healed by primary union and all the sutures were removed. Chest was aspirated at 2 sites in the fifth and sixth interspaces posteriorly. No fluid was obtained. The thoracotomy tube was not draining. The heart was not displaced. Blood pressure was 150/90. A policy of watchful waiting was adopted.

Eighth day. Condition markedly improved today. Temperature was 99 degrees Fahrenheit, pulse 90, respiration 22. The intercostal drainage tube was removed. Small amounts of fluid fed through gastrostomy tube.

Tenth day. Hemoglobin was 70 per cent, red blood cells 4,420,000, white blood cells 24,000, polynuclear leucocytes 84 per cent, monocytes 1 per cent, lymphocytes 15 per cent.

Eleventh day. Condition was steadily improving. Regular feedings by gastrostomy tube were given every 2 hours. Examination of the chest indicates signs of fluid at the left base posteriorly and in the axillary line. Aspiration in the eighth interspace showed clear yellow serum. Culture was reported negative.

Thirteenth day. Patient became ill with dyspnea, pain over the front of the left chest, a temperature rise to 103.2 degrees, pulse 120, respiration 40. Examination showed signs of fluid in the left chest below the spine of the scapula with a definite pleuro pericardial friction rub.

Fourteenth day. About 4:00 a.m. a large amount of serous fluid escaped from the original intercostal drainage incision and all of the patient's symptoms abated. X ray

examination of the chest showed a moderate amount of fluid in the left pleural cavity displacing the heart and mediastinum slightly to the right. The fluid showed a distinct level in the mid portion of the chest. Accordingly aspiration was performed in 2 places: (1) the axillary line in the sixth interspace and (2) in the scapular line of the eighth interspace. In both situations clear yellow fluid was obtained. This was thought to represent a sympathetic effusion due to an underlying collection of pus within the chest. A clamp was inserted in the original intercostal incision and thick pus was encountered. A tube was inserted for drainage.

On the basis of this finding the patient was taken to the operating room on the fifteenth postoperative day. The intercostal incision in the eighth interspace was enlarged. With adequate retraction it was not necessary to resect a rib. There was found a small walled-off abscess cavity situated apparently in the lower portion of the posterior mediastinum. This contained about 1½ ounces of greenish white odorless pus. In addition there was a sympathetic effusion with beginning turbidity in the anterior portion of the chest. The mediastinal infection was packed with iodoform gauze and tubes were inserted to drain the anterior pleural effusion. From that day on the patient's condition improved rapidly. Another transfusion of 500 cubic centimeters of blood was given on the sixteenth day. The abscess cavity in the left chest gradually contracted down and all drainage stopped during the next 2 weeks.

In the meantime the patient had been receiving gastric feedings with a daily caloric value of 2600 and containing approximately 250 grams of carbohydrates, 75 grams of proteins and 160 of fat. The food contained all the necessary vitamins and minerals. During the third week a rubber esophagus was inserted and the patient began to take most of the feeding by mouth. The patient lost approximately 20 pounds during her stay in the hospital. She was discharged exactly 8 weeks after the resection in excellent condition, taking all her feedings by mouth and with the thoracic wounds solidly healed (Figs 17, 18, 19, 20).

During the following 2 months the patient began to have considerable difficulty with the rubber esophagus. This consisted mainly of sudden leakage of food around the tube at the upper fistula with its attendant soiling and discomfort to the patient. After considerable study the cause for it was finally determined. It was noted that the patient while eating swallowed a considerable amount of air. During the course of the meal the column of swallowed air was seen to rise higher and higher in the rubber esophagus until a considerable reservoir was formed in the esophageal stump above the fistula. There soon followed a strong contraction of the remaining esophagus with ejection of air and food food from the fistula. Various ingenious devices were made by Dr S. Margolin to overcome this but leakage still occurred.

Finally it was decided to construct a skin lined esophagus continuous with the esophagus above and terminating a few inches above the gastrostomy opening in the hope that it would act as a reservoir for the food ejected downward by the esophagus above. Accordingly the patient was readmitted to Mount Sinai Hospital and operated upon on June 24, 1937. The operative note reads as follows: Two parallel incisions were made extending from the level of the upper esophagus stump downward to about the level of the ensiform cartilage, thus creating a flap 3 inches wide and 5½ inches long. The skin and subcutaneous tissues on the lateral margins of the flap were undermined for a distance of 1 inch on each side leaving the middle portion attached to the underlying tissues in order to ensure a good blood supply. The flap was turned forward so as to have the skin surface face internally. The skin edges

CYSTECTOMY AND TRANSPLANTATION OF THE URETERS INTO THE BOWEL FOR CARCINOMA OF THE BLADDER

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IN RECENT years, transplantation of the ureters into the pelvic portion of the colon and cystectomy have become accepted as standard surgical procedures in the treatment of certain pathological lesions

Prior to the advent of intravenous urography, it was impossible to study the physiology and dynamics of the upper urinary tracts following transplantation, but a method is now available by which visual interpretation of results may be secured years after operation. In view of these investigations, the excellent clinical results, and low morbidity and mortality, the applicability of this method of treatment of exstrophy of the bladder is not a subject of controversy. The same procedure is also accepted for conditions such as vesicovaginal fistula in which a plastic operation does not suffice to render a cure, certain groups of patients with chronic interstitial cystitis, tuberculous cystitis with marked diminution in the bladder capacity and intolerable pain in which a nephrectomy has been performed previously for renal tuberculosis while the other kidney and ureter remain normal, and carcinoma of the bladder in a selected group of patients

The reluctance of surgeons to accept the operation of total cystectomy has been due not to the technical difficulty of removing the bladder, but rather to a divergence of opinion as to the most satisfactory method of disposing of the ureters. For this, 4 methods are available: (1) nephrostomy, (2) pyelostomy, (3) ureterostomy, (4) transplantation of the ureters into the rectosigmoid

While the first 3 procedures may satisfy the immediate requirements, they possess distinct disadvantages. Early and serious renal infection ensues and this is followed by impairment of renal function. The patient must also endure the inconvenience of wearing a receptacle to collect the urine, the unavoidable odor of which renders it difficult to maintain social and business activities. But, by the implantation of the ureters into the bowel, experience has conclusively demonstrated that the rectum serves adequately as a

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reservoir for the urine without distressing the patient with frequent excursions to the toilet. In addition, intravenous urograms have revealed normal upper urinary tracts years after operation in many instances. Conversely, it is true that years following transplantation of the ureters into the rectosigmoid, intravenous urographic studies may reveal dilatation of the ureters and hydro-nephrosis due to ureteral obstruction. With refinements in operative technique, however, this complication is gradually occurring less frequently

In advocating cystectomy and transplantation of the ureters for carcinoma of the bladder, several important factors must be taken into consideration.

Accurate diagnosis early in course of disease
The cardinal symptom of a bladder tumor is hematuria. As a general rule, this alarms the patient sufficiently that he consults a physician for advice.

The report of the Registry of Carcinoma of the Bladder of the American Urological Association (4) offers valuable information regarding the period of time elapsing from the onset of symptoms until an accurate diagnosis is established. In the series of 694 cases in which the character and duration of the initial symptoms were known, it was found that in 10.8 per cent of the cases the diagnosis was established within 1 month after onset of the initial symptoms, in 32.13 per cent within 5½ months, and in 51.7 per cent before a year had elapsed, while in 48.3 per cent a diagnosis was established more than 1 year after the appearance of the initial symptoms. The initial symptom in 63.5 per cent of the cases was hematuria; therefore, an early diagnosis of this condition can frequently be established and by routine employment of the cystoscopic examination the percentage of accurate diagnoses will increase considerably.

Various other symptoms, such as the passage of clots, frequency, and dysuria, may similarly induce the patient to seek relief. It is evident then that carcinoma of the bladder produces symptoms sufficiently alarming that medical advice is sought relatively early. This is in contrast to malignant processes in some other parts of the body where more vague, bizarre complaints

culty was noted. Pulse varied between 116 and 138. Heart was not displaced. Patient was encouraged to swallow water thus helping to flush the esophageal stump.

Third day Temperature was 100.4 degrees Fahrenheit. pulse 100 respiration 20. General condition of patient was excellent. Two ounces of serosanguineous fluid drained through the intercostal tube. Feedings by gastrostomy tube were instituted today.

Fourth day Condition good. Temperature 101 degrees Fahrenheit. Respiration was 20 pulse 102.

Sixth day Temperature was 100.4 degrees Fahrenheit. His general condition was excellent. Two ounces of slightly blood tinged serous fluid drained through the intercostal tube. The cervical incision was dressed and silk sutures were removed. The wound healed by primary union.

Seventh day General condition was excellent. Intercostal drainage tube was removed. The thoracic incision was inspected and found clean. Skin sutures were removed. Patient receiving regular gastrostomy feedings.

Eighth day Temperature was 100 degrees Fahrenheit. pulse, 90 respiration 20. Patient was allowed out of bed. X-ray examination of chest showed complete expansion of the left lung with slight haziness in the lower portion which was interpreted as representing a small amount of fluid. The stump of the esophagus was healing nicely.

At present writing 2½ weeks after operation patient is in excellent condition. Thoracic wound has healed. Rubber esophagus is in place and patient is taking all food by mouth. It is expected patient will be discharged from hospital shortly.

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less than 2 centimeters in diameter were controlled for 5 years, but if the tumors were larger than 5 centimeters, only 15.8 per cent of the patients were alive at the end of 5 years.

In conclusion as to the general end-results in carcinoma of the bladder at the present time, the registry stated of 658 patients operated upon before January 1, 1931, 151 survived for 5 years. Of this entire group, 104 or 15.9 per cent *were reported to be without evidence of cancer*. Therefore, can we prognosticate that only 15.9 per cent of patients with carcinoma of the bladder will survive for 5 years without evidence of cancer unless cystectomy and transplantation of the ureters are employed? In answering this question, the causative factors responsible for death of patients with carcinoma of the bladder obviously must be considered.

The incidence of metastasis is a disputed question. Of 902 cases carefully studied by the carcinoma registry, metastases were present in 72 instances. However, no accurate report could be given as to the number of examinations made in which no metastases were found. Metastases occurred in the following locations, arranged in order of their frequency: bones, lungs, regional nodes, liver, retroperitoneal nodes. At the Mayo Clinic, metastases were found at autopsy in 30 per cent of the cases and visceral involvement was present in one-half of these. Caulk states that metastases were present in 25 per cent of his cases. Smith, at the Massachusetts General Hospital, reports a higher incidence—40 per cent; Beer has stated that metastases were present in about 10 per cent of his cases, while in our group at the Cleveland Clinic, between 10 and 12 per cent showed metastatic lesions. Therefore, metastasis from the primary growth is not the cause of death in the majority of cases.

The site of predilection for carcinoma of the bladder is the region near one of the ureteral orifices. As the growth enlarges, ureteral obstruction ensues and this is followed by irreparable damage to the upper urinary tract. Caulk, in 1935, admirably discussed this problem and emphasized the fact that death frequently does not occur from the malignant lesion *per se*, but rather from urosepsis. As the obstruction induced by the involvement of the ureteral orifice continues, dilatation of the ureter, stasis, and hydronephrosis occur. The infection which invariably follows is attended by pyelonephritis, pyonephrosis, and eventually impairment of renal function occurs with complete destruction of the kidney.

The location of the tumor influences the results that can be anticipated, aside from the grade of

the tumor. A small grade I tumor involving the ureteral orifice may already have destroyed the kidney when a patient is first seen, while a grade II or III tumor which is located higher on the lateral wall may be radically excised before it involves the ureteral orifice with secondary involvement of the upper urinary tract. Interpretation of the cystoscopic picture may be misleading and involvement of the ureter, though present, may not be suspected. When involvement of the ureter is present, however, the cystogram may show more extensive infiltration of the bladder wall and ureteral regurgitation may be evident. We believe that a cystogram should be made in all cases of carcinoma of the bladder.

Postmortem study on several occasions has revealed urosepsis to be the cause of death while the carcinoma was still limited to the confines of the bladder. In reviewing 300 cases, Caulk stated that evidence of renal infection was present in 21 per cent while Barringer found infection in 16 per cent of his cases. In our series, evidence of renal infection was found in 19 per cent. Perhaps the most striking statistics on the cause of death are those of Caulk who found records of death in 90 of his 300 cases, and of these, 25 came to post-mortem. He found evidence of renal disease in 34, or 38 per cent. Of the 25 cases which came to autopsy, 15, or 60 per cent, died a renal death.

It is likewise well to recall that repeated fulgurations of tumors near the ureteral orifice may lead to stenosis of the ureteral orifice with resultant involvement of the upper urinary tract. It is therefore estimated that in over 50 per cent of all cases, renal failure and urosepsis secondary to involvement of the ureters are contributory factors causing death.

CYSTECTOMY AND TRANSPLANTATION OF URETERS

Age of the patient. In considering cystectomy and transplantation of the ureters as a treatment for carcinoma of the bladder, certain problems arise which are in contrast to those present when the operation is designed for the relief of exstrophy in children. While the age of the patient is of considerable importance, the presence of co-existing pathological processes is more evident, such as hypertension, myocardial degeneration, general disability, or renal insufficiency. Individualization is necessary to determine whether cystectomy can safely be advocated or whether less radical procedures should be instituted. In our series of 34 cases of carcinoma of the bladder in which transplantation of the ureters into the sigmoid and cystectomy have been performed,

are produced, these being of insufficient severity to cause the patient to seek medical consultation until the lesion is well advanced.

Results secured by treatment other than cystectomy and factors influencing the end results. A review of the methods employed in the treatment of carcinoma of the bladder reveals that no standard method has been adopted and further that various factors influence the procedure instituted.

The size of the tumor and its character—whether infiltrating or papillary—definitely influence the end result and are of prognostic significance. The grade of the tumor, according to Broders' classification, the position of the tumor in the bladder, and whether single or multiple tumors are present are all of definite clinical significance and are of importance in evaluating the suitability of cystectomy as the procedure of choice.

The 854 tumors of the bladder reported by the Carcinoma Registry were found in the following locations: trigone, 32.2 per cent, lateral walls 35.3 per cent, posterior wall, 10.2 per cent, bladder neck 9 per cent, vault 7.5 per cent, and the anterior wall 5.7 per cent. More important however was the observation that of the 854 cases one area of the bladder only was involved in 473, namely trigone, 27.37 per cent, bladder neck 5.89 per cent, lateral walls, 41.89 per cent, posterior wall 10.92 per cent, anterior wall 6.12 per cent and the vault, 7.58 per cent.

These statistics are of great importance in determining the treatment to be employed. Tumors on the low lateral walls usually involve the ureteral orifice on the same side. In our series we found that if tumors of the trigone and bladder neck were included, complete excision of the growth without injury to the ureters or damage to the vesical sphincter, the later resulting in incontinence, was technically impossible in 72.5 per cent of the cases. Obviously when the tumor occupies a position low on the lateral wall, wide excision of the bladder with reimplantation of the ureter into another portion of the bladder is possible. Thus, in only 27.5 per cent of our series—and this figure agrees closely with that of the Carcinoma Registry (23.4 per cent)—was complete excision possible without either reimplanting a ureter into another part of the bladder or injuring the bladder neck. While carcinoma involving the vault of the bladder is readily accessible to resection, it is extremely malignant and metastasis occurs to the liver by way of the lymphatics of the obliterated hypogastrics.

Considerable stress has been placed upon accurate grading of the tumor according to Broders'

classification. What is the incidence of bladder tumors of low grade malignancy in which the prognosis should be more favorable?

Of a series of 902 cases studied by the Carcinoma Registry, 436 were papillary carcinoma while 446 were infiltrating carcinoma, and 20 were not definitely classified. Let us now note the end results secured for tumors of varying degrees of malignancy according to Broders' classification, the analyses being made from a series of 658 epithelial tumors reported by the Carcinoma Registry. Of 133 tumors classified as grade I, 61 or 45.9 per cent of the patients were alive 5 years, of 194 patients with grade II tumors 50 or 25.7 per cent were alive at the end of 60 months, of 244 with tumors grade III, 34 or 13.9 per cent survived 5 years and in 70 with tumors grade IV, 4.3 per cent were alive 5 years. This report, however, contains only data on patients who survived 5 years and does not exclude patients with recurrences who may not survive 6 or more years. The report indicates that the cancer may be under control.

The question arises as to what results may be obtained in the treatment of carcinoma of the bladder and why there is such discrepancy when end results of treatment of carcinoma of the bladder are compared with those for carcinoma in other accessible parts of the body.

In dealing with tumors of the bladder of the lowest grade of malignancy according to Broders' classification (i.e. grade I) should we be satisfied that only 45.9 per cent of the patient survive for 5 years and for the 2 lowest grades of malignancy (i.e. grades I and II), can we expect only 35.8 per cent of the patients to live for 5 years? It is true that these statistics were compiled from the reports of many surgeons and that more favorable results have been presented by some authors but they do represent an average of the results being secured at the present time.

It is also true that these results are for both infiltrating and papillary tumors, however of 151 patients surviving 5 years the tumor in 109 cases was of the papillary type 34 were infiltrative and 8 were not classified. In the group of 31 patients who were operated upon for papillary tumors 34.9 per cent survived for 5 years. Is this the best result that can be secured in this type of tumor which is not infiltrating in character? It is likewise interesting that only 13.9 per cent of the patients with the infiltrating type of carcinoma of the bladder were stated to be cured.

The size of the tumor in the bladder is of prognostic significance. The report of the carcinoma registry stated that 30.3 per cent of the tumors

such that their implantation into the bowel is technically possible.

4. As Quinby has mentioned, demonstration of an actively growing carcinoma should be made by microscopic examination (biopsy).

During the last 2 years, cystectomy has also been performed in a selected group where radical segmental excision of the bladder was not possible and where we believed that insufficient radium could be implanted in the tumor to completely destroy it. Similarly, when a cystogram revealed evidence of much more extensive involvement of the bladder wall than was suspected by the cystoscopic picture, the radical operation was recommended.

Pre-operative care. In discussing carcinoma of the colon Dr Fred Rankin states, "No operative step in the treatment of malignancy is of more importance than the initial preparation, particularly in the face of obstruction. The chronic obstruction does not necessitate an emergency procedure and operative measures are greatly facilitated and end-results influenced by giving some time to pre-operative measures."

In transplanting the ureter into the rectosigmoid, preparation of the bowel is likewise essential. Our pre-operative routine is similar to that used by Dr T. E. Jones in preparing patients for operations on the colon.

1. A liquid, non-residue diet is supplemented by candy, glucose, and gelatin.

2. One thousand cubic centimeters of a 10 per cent solution of glucose are administered intravenously each day. The glucose is given with saline solution if the kidney function is not impaired but, if the function is decreased, distilled water is substituted for the saline solution.

3. Magnesium sulphate is administered orally each day. One ounce of magnesium sulphate is dissolved in 8 ounces of water, 1 ounce of this mixture being taken every half hour starting at 7 a. m. None, however, is used on the day prior to the operation.

4. The bowel is cleansed with an enema daily.

5. Provided there are no other complications, the number of days of preparation before operation depends upon the renal function and the cleanliness of the bowel. When all enemata return clear, the bowel is considered clean. The day before operation, an enema is given both in the morning and at night.

6. Three doses of paregoric, each of 2 drams, are prescribed at intervals of 2 hours, usually from 4 to 8 o'clock the night before operation.

7. Blood transfusions are used when indicated by condition of patient and blood picture.

8. Complete study of upper urinary tract is made by tests of function and intravenous urography.

9. Urinary antiseptics intravenously or orally are administered as indicated.

10. Miscellaneous supportive measures are employed as necessary.

Since this pre-operative routine has been employed, convalescence has been more smooth and complications have definitely been reduced. Certainly the adequate pre-operative preparation of the colon minimizes the possibility of peritonitis and of acute ascending infections of the kidney following the operation. Many of these patients are debilitated, and increased resistance to infection, restoration of the water balance to normal, and improvement of the renal function are essential measures which result in elimination or reduction of postoperative complications.

Operation. The operation to be recommended in a given case is influenced by the general condition of the patient, renal function, caliber of the ureters, and the presence or absence of renal infection. One of two surgical procedures is usually employed—either the Coffey I operation or that advocated by us in 1933 (5).

When the Coffey I technique is employed, unilateral transplantation of the ureters is advisable. This is attended by a lower mortality than is the case when both ureters are simultaneously transplanted by this method. At the time the right ureter, which is the first to be transplanted into the rectosigmoid, is done, it is advisable to explore the abdomen for metastasis, glandular involvement, or extravesical extension. Ten to 12 days later, the left ureter may be transplanted into the rectosigmoid if there are no contraindications. After the transplanted ureters are functioning well, as indicated by intravenous urographic studies, cystectomy is performed. The postoperative reaction following transplantation of the first ureter is usually more pronounced than that following transplantation of the second ureter, an elevation of temperature and increase in the pulse rate usually occurring for a few days and then gradually returning to normal.

The Coffey I procedure is preferable in cases of impaired renal function or in instances when varying degrees of dilatation of the ureters are present.

In another group of cases, however, when the ureters are of normal caliber or are only slightly dilated, when the renal function is only slightly impaired, and when the physical condition of the patient is satisfactory, we believe that both ureters may be transplanted simultaneously by the

1 patient was 77 years of age 9 were more than 60 years of age, 8 were between 50 and 60 and the 16 remaining were less than 50 years of age

The maximum age limit at which the operation is advisable is influenced by the general condition of the patient, the findings at cystoscopic examination, the status of the kidneys and ureters, and the presence or absence of co-existing pathology

Treatment A discussion of the various types of treatment of carcinoma of the bladder is beyond the scope of this paper Only facts of significance regarding carcinoma of the bladder are discussed and our opinion regarding cystectomy at the present time is presented

In the treatment of carcinoma in general there has occurred an extension of the range of operability with an accompanying decrease in the morbidity and mortality This is evidenced by the results secured by laryngectomy for intrinsic carcinoma of the larynx, by radical operations for carcinoma of the stomach and colon, and now lobectomy for carcinoma of the lung

Rankin states that since 1900 radical operations for treatment of cancer of the colon have gradually evolved into satisfactory technical procedures and this has been accompanied by a slow but gradual decrease in the mortality We believe the same thing will happen in cystectomy and transplantation of the ureters into the bowel for selected cases of carcinoma of the bladder At the present time cystectomy is looked upon as a 'court of last resort' in many instances and is instituted only for well advanced carcinoma of the bladder or when conservative procedures have failed

Obviously, if the operation is employed in the group of patients who already have pyelonephritis impaired renal function, and large dilated ureters, thus rendering the operation technically difficult or impossible, a higher mortality will result than when no complicating factors are present Certainly the range of operability is by no means 100 per cent, even if the bladder can be removed *in toto* As the continuity of the sigmoid or rectosigmoid cannot be restored in all cases following the radical removal of a carcinomatous lesion in like manner the condition of the upper urinary tract may not justify implantation of the ureters into the colon or even cystectomy in all cases and palliative treatment must be advised in certain instances That cystectomy and transplantation of the ureters into the rectosigmoid can be accomplished with a low mortality in adults is evidenced by the results secured in a selected group of patients with interstitial cystitis and vesicovaginal fistula Here

again the low mortality and morbidity are due to good renal function, absence of or minimal amounts of renal infection, and normal caliber of the ureters

Thus in patients with carcinoma of the bladder in whom infection of the kidneys is either not pronounced or entirely absent, when renal function is not impaired, and when the ureters are normal or only slightly dilated, we can expect satisfactory end results and a material reduction in the mortality If cystectomy were employed would not more than 15 per cent of patients, as reported by the carcinoma registry in which other types of treatment were used, be free from cancer at the end of 5 years?

We now recommend cystectomy and transplantation of the ureters into the rectosigmoid in the following groups of cases

1 When the carcinoma is located at the base of the bladder and the ureteral orifices are encroached upon or the vesical sphincter is so involved that adequate local treatment would exert a destructive action on the ureteral orifice or would cause incontinence

2 When more extensive single or multiple infiltrating tumors are present

3 When multiple, recurring tumors develop rapidly and cannot be controlled by fulguration so that they eventually fill the bladder

In addition to these 3 groups of cases certain other factors must be taken into consideration before the radical operation is recommended

1 Renal function must be satisfactory, preferably in both kidneys, but at least normal in one kidney In 3 instances we have transplanted the ureter from the normal kidney into the bowel, finally performing the cystectomy after removing the opposite kidney because of infection and complete loss of function as the result of a bladder tumor obstructing the ureter

2 The presence of metastases or evidence of local extension of the malignant lesion must be taken into consideration If, at the time of transplantation of the ureters, clinical evidence of extension of the carcinoma beyond the confines of the bladder is noted we believe that the radical operation is inadvisable Palpation of the regional lymph nodes and those at the bifurcation of the aorta is a routine procedure As these glands are not removed in their entirety if involved, local recurrence would obviously ensue Roentgen ray study to exclude the possibility of metastasis to the chest is advisable in all such cases

3 Intravenous urograms should be made to demonstrate that the calibers of the ureters are

ureter protruding into the lumen of the bowel may become markedly edematous and the site of an acute inflammatory reaction for a few days. This is conducive to obstruction of the passage of urine into the bowel. As a general rule, however, intravenous urographic study reveals that stasis disappears in a few days. If temporary obstruction occurs when the ureter from a single kidney has been transplanted, a temporary pyelostomy or nephrostomy may be employed. We have not, however, found it necessary to employ this procedure.

Immediate use of urinary antiseptics as a preventive measure is also made. We have employed salihexin which is administered intravenously or more recently we have used mandelic acid by mouth.

Later complications may be: (1) dilatation of ureters and hydronephrosis; (2) renal infection; (3) impairment of renal function; (4) recurrence of malignancy.

In some instances urographic studies reveal the presence of hydro-ureters and hydronephrosis years after implantation of the ureters into the bowel. In other cases, similar studies reveal the ureters and kidneys to be in fairly normal condition years after operation. Again the causative factors responsible for the dilatation of the ureters are not clearly understood. It does appear, however, that with experience and refinements in operative technique, the incidence of this complication is progressively diminishing. Even though this complication may occur, years of comfort are added to the lives of the patients and they may be restored to society for a long period of time before succumbing to other diseases remote from the one for which operation was performed.

Some patients may be free from urinary sepsis for years, in fact, we have patients in whom evidence of renal infection is absent 10 to 15 years following transplantation of the ureters. The late infection usually occurs in patients in whom stasis, dilatation of the ureters, and hydronephrosis are demonstrated by intravenous urography. These patients may have periodic attacks of renal infection which subside rapidly upon the administration of urinary antiseptics. It is undoubtedly true that some degree of ureteral obstruction, with resulting stasis, is the responsible etiological factor in this group.

The presence of late ureteral obstruction frequently antedates impairment of renal function. When a superimposed renal infection occurs, renal function may be damaged rapidly. If pyelonephritis does not occur, however, the function may not be impaired to any pronounced

degree for years. We have patients who have had periodic attacks of pyelitis years following transplantation of the ureters into the rectosigmoid but the intravenous urogram revealed only slight impairment of renal function.

It is likewise true that impaired renal function may not be demonstrated in many cases several years after the implantation has been performed and the dynamics and physiology of the upper urinary tract remain fairly normal.

Recurrence The incidence of a local recurrence of carcinoma following cystectomy at the present time is difficult to determine. Before statistics are reliable, a sufficient number of cases must be followed for a period of years. In this series of 34 cases, insufficient time has elapsed since operation to present statistics which may reveal the true picture. If, however, no evidence of distant metastases is noted at the time of operation, if glandular involvement is absent, and extravesical extension cannot be demonstrated, recurrence should occur in but a small percentage of cases.

CONCLUSIONS

1. Cystectomy and transplantation of the ureters has been performed in 34 of our patients with carcinoma of the bladder.

2. A reduction in the mortality has been observed by performing the operation before dilatation of the ureters, renal infection, and impairment of renal function have occurred.

3. Less radical operative procedures should be employed in advanced cases of carcinoma of the bladder associated with large dilated ureters, pyelonephritis, and impaired renal function. Such vesical carcinomas lie beyond the range of operability for this type of surgical procedure.

4. The question is raised as to the advisability of earlier transplantation of the ureters and cystectomy before irreparable damage to the kidneys has developed.

5. In the group of patients surviving operation—and this percentage is gradually increasing—control of the urine is satisfactory and they may return to their social and business activities in comfort.

6. Insufficient time has elapsed to warrant statements as to the percentage of 5 year cures. The immediate results are, however, gratifying and we are quite optimistic concerning the results that may be secured.

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transfixion suture method. As the continuity of the ureters is not interrupted until new channels are established, there is no interruption of kidney function throughout the entire operation.

In some instances in which considerable fat is present in the mesentery it has been found impossible to employ this technique without too much tension upon the line of anastomosis. Thus individualization is necessary and the operative procedure to be employed depends upon the familiarity of the surgeon with the various operative techniques and the clinical findings prior to and during the operation.

The use of ureteral catheters is usually unnecessary. We have utilized the catheter principle in two instances in which the ureters from solitary kidneys were transplanted into the rectosigmoid to eliminate the possibility of temporary obstruction.

Postoperative care. An exacting postoperative regimen is essential, and the following routine has given the most satisfactory results in our hands.

1 The patients are maintained in a supine position for at least 8 hours if spinal anesthesia is used; then they are placed in Fowler's position.

2 The blood pressure is taken every 15 minutes until it returns to normal.

3 No fluids are administered by mouth for 48 hours and then small amounts of water are taken orally for 12 hours. During the following 12 hours, clear fluids are started with 1 ounce hourly, and this amount is gradually increased. A low residue diet is then given for a period of 5 to 7 days.

4 The fluid intake is maintained at 3,000 cubic centimeters daily. For the first 2 days, 2,000 cubic centimeters of 10 per cent solution of glucose is administered intravenously and 1,000 cubic centimeters of saline solution infusion daily. After this period, fluids are given intravenously as indicated by a study of the blood chemistry and the amount of fluid taken by mouth.

5 Narcotics are given as necessary.

6 A rectal tube is inserted at the time of operation. This may be changed but is replaced and left in the rectum for a period of 8 to 10 days. The rectal tube is irrigated gently at intervals of 2 to 3 hours to insure patency. When the transfixion suture technique is employed, gentle traction is made on the rectal tube at the end of 24, 36, and 48 hours until the tube containing the silk sutures is expelled. A plain rectal tube is then reinserted for a period of 5 to 7 days.

7 Studies of the blood chemistry (urea and creatinine) are made daily until the levels return to normal.

8 Ten cubic centimeters of salixerin are combined with the intravenous glucose as a urinary antiseptic for the first 3 or 4 days following operation.

9 General supportive measures are prescribed as indicated.

Anesthesia. Spinal anesthesia has been the anesthetic of choice in our patients. The complete relaxation induced by this type of anesthesia facilitates the ease with which exploration of the abdomen for metastases may be accomplished without excessive manipulation of the intestines. Similarly, exposure may be adequately secured without undue or excessive packing off of the operative field with numerous tapes.

More important is carrying the operation down to the colon so the danger of tenion on the ureter or kinking of the ureter does not occur, a condition which is always a possibility if the anastomosis is performed with the rectosigmoid delivered well up into the incision.

Obviously if contra indications to the use of spinal anesthesia exist it is not used and gas-ether anesthesia is employed.

Complications. The immediate complications are (1) peritonitis, (2) acute renal infection (pyelonephritis), (3) temporary ureteral obstruction.

Careful pre-operative preparation of the bowel and utilization of the Coffey submucous technique for transplantation of the ureter into the rectosigmoid have reduced the incidence of peritonitis to a minimum. By adequate preparation of the colon the danger of leakage of the contents of the bowel into the abdominal cavity at the time of operation is eliminated as one source of peritonitis. Second, the submucous principle of implantation prevents leakage following the operation.

Acute infections of the urinary tract constitute the major complications following transplantation of the ureters into the bowel. The exact mechanism instrumental in the production of the acute pyelonephritis is a debatable question. Certainly, however, we have noted a decrease in the incidence of this complication since an adequate pre-operative regimen has been established. Likewise, prevention of stasis in the upper urinary tract by not approximating too tightly the layers of the bowel over the ureter is an important technical consideration.

Temporary obstruction of the ureter may occur. This may be due either to edema at the site of the incision in the bowel wall in which the ureter is incorporated or as demonstrated experimentally by Vermooten and ourselves, the portion of the

ureter protruding into the lumen of the bowel may become markedly edematous and the site of an acute inflammatory reaction for a few days. This is conducive to obstruction of the passage of urine into the bowel. As a general rule, however, intravenous urographic study reveals that stasis disappears in a few days. If temporary obstruction occurs when the ureter from a single kidney has been transplanted, a temporary pyelostomy or nephrostomy may be employed. We have not, however found it necessary to employ this procedure.

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It is likewise true that impaired renal function may not be demonstrated in many cases several years after the implantation has been performed and the dynamics and physiology of the upper urinary tract remain fairly normal.

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CONCLUSIONS

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3. Less radical operative procedures should be employed in advanced cases of carcinoma of the bladder associated with large dilated ureters, pyelonephritis, and impaired renal function. Such vesical carcinomas lie beyond the range of operability for this type of surgical procedure.

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CARCINOMA OF THE THYROID

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THE incidence of malignant disease of the thyroid gland among goiters of all types averaged from the reports of 11 authors, is 2.37 per cent (5, 9, 18, 20, 24, 25, 26, 27, 28, 31, 32).

According to Joll, about 90 per cent of thyroid malignancies are epithelial in origin, and Broders agrees with Ewing that practically all primary malignant neoplasms of the thyroid are carcinomas. These malignant epithelial tumors are usually subdivided into 3 main groups: papillary adenocarcinoma, adenocarcinoma in adenomas, and the so called diffuse adenocarcinoma.

Papillary carcinomas constitute a well defined group and in the early stages are soft and friable but may later become cystic and calcified. Their growth is slow, sometimes with multiple localized foci. Their malignancy varies but it is usually of low grade (I or II). Their histological picture is in a degree, similar to that of papillary tumors of the ovary. Blood vessel invasion is not common. Extension is nearly always local but early, and is by way of the lymphatics. Recurrence is common and is apt to take place within a year if at all. These are the most radiosensitive of all thyroid cancers. The incidence is, roughly, 30 per cent.

Adenocarcinoma in adenomas. The tumors are large and solid, well encapsulated and with a lobulated texture. They have a reddish color due to high vascularity and are frequently soft. They usually arise in a pre-existing goiter, a goiter usually produced by a fetal adenoma. This type metastasizes late, and, through the blood vessels to distant organs. It represents about 45 per cent of thyroid carcinomas.

From the Geisinger Memorial Hospital.

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Diffuse adenocarcinomas constitute the third group of carcinoma of the thyroid and are the most malignant variety. Grossly and macroscopically there is but little distinct division from adenocarcinoma. The onset is acute, with or without a preceding goiter. Metastasis occurs early, and both locally and distantly. Their structure varies from that of adenocarcinoma to diffuse solid masses of carcinoma cells with no alveolar formation. Prognosis is grave.

Squamous cell epithelioma occasionally occurs in the thyroid gland. Not infrequently it appears as an extension from carcinoma of the esophagus or trachea yet cases have been reported which arose from metaplastic thyroglossal duct epithelium.

Sarcoma of the thyroid should be mentioned, yet Ewing denies its existence, stating that so called sarcomas are anaplastic carcinomas belonging in the diffuse group.

Other malignant tumors that appear in the thyroid gland are hemangio-endotheliomas and teratomas. Metastatic tumors to the thyroid are rare but include hypernephroma, carcinoma of the tongue, breast, stomach, esophagus and lung.

It has long been felt that all tumors of the thyroid originate in fetal adenomas. Habermel (1934) believes that 90 per cent of thyroid cancers arise in fetal adenomas and that these are true neoplasms in themselves arising from one of embryonal cells which may, for years, remain dormant. Crile (7) and Lahey agree with Habermel. Habermel stated that thyroid malignancy is more common in endemic goiter districts, and most frequent in long standing, nodular goiters. This latter statement is universally recognized, namely, that a pre-existing goiter, of from 1 to 25 years duration has been present in almost all

carcinomas of the thyroid. The sex incidence is predominantly female in all reports, although the proportion varies.

Blood vessel invasion has become an important criterion in determining malignancy. European authors, Wylegshanin and Viallefont, as well as many American authors, notably Graham, have emphasized it. Means (1937) emphasizes Warren's earlier findings that simple colloid goiters never show blood vessel invasion. T. B. Mallory, however, demands that a vessel large enough to possess muscularis be penetrated by the malignant tissue, in order to exclude artefacts. The slow growing, less malignant papillary tumors and the very malignant anaplastic ones seem to have a tendency toward local spread with production of compression symptoms while an encapsulated adenocarcinoma may show distant blood borne metastasis regardless of its degree of malignancy.

Metastases from carcinoma of the thyroid gland are found, primarily, in the cervical and axillary nodes, lungs and mediastinum, bones, liver, brain, kidney, and pleura, in about that order.

Among the bones the skull, long bones, spine, and thoracic cage are most frequently involved.

The histological appearance of metastasis may differ considerably from the original tumor, i.e., both may appear benign or both malignant, or either one may be malignant and the other benign (Ewing). The so called benign metastasizing goiter is now regarded as a form of adenocarcinoma.

Aberrant lateral thyroid tissue as a source of carcinoma of the thyroid has been considered by Cattell (3), Forty, Greensfelder and Bettman, Greteman and Russum, and Moritz and Bayliss. Lateral aberrant thyroid tissue is frequently unrecognized or is mistaken for lymph-nodes or branchiogenic cysts. There seems to be a well recognized tendency for this tissue to become malignant. The carcinoma, it is claimed, is usually papillary and of low grade malignancy and responds well to treatment. In regard to this question, it should be mentioned that some pathologists, including Broders, question whether carcinoma of the thyroid originating in aberrant thyroid tissue is frequently or ever seen.

Carcinoma of the thyroid has been reported in children by Cattell (4) and by Kennedy. It is usually of the papillary adenocarcinomatous type and of low grade malignancy. In Cattell's series trauma seemed to be frequently associated with a development of the thyroid tumor.

CLINICAL DIAGNOSIS

It has been stated that, if carcinoma of the thyroid can be recognized clinically, it is usually too late to cure the patient. The usual clinical picture is one of a distorted, hard, lobulated, rapidly growing goiter, associated with hoarseness, respiratory stridor, dysphagia, and neuralgic pains in the head and neck. Sympathetic eye signs may occur, and redness of the overlying skin sometimes occurs with ulceration. Hemoptysis may appear as a result of pulmonary metastases, or erosion into the trachea or larynx. Walton states that carcinoma usually becomes fixed to the trachea before adhering to the overlying skin.

Means stresses the point that the presence of either hyperthyroidism or hypothyroidism is against the diagnosis of cancer. Chronic thyroiditis such as the struma lymphomatosa of Hashimoto, and chronic non-suppurative thyroiditis, or metastatic infections, must be ruled out in the differential diagnosis of cancer of the thyroid. It must be remembered, however, that infection is often superimposed on malignancy. Tuberculous and syphilitic infections of the thyroid are exceedingly rare.

The diagnostic value of the absence of hyperthyroidism has been stressed by some authors. Others report the frequent association of hyperthyroidism with malignancy. Clute and Warren state that there is no evidence that hyperthyroidism arises as the result of the activity of malignant tissue, although malignant thyroid tissue may secrete colloid. Means goes so far as to say that hyperthyroidism is "insurance against carcinoma of the thyroid." George Crile, Jr. notes the marked disagreement in the literature over this point.

TREATMENT

Successful prophylactic treatment of carcinoma of the thyroid depends upon the enucleation of all thyroid adenomas as they appear. It is impossible to recognize nearly 50 per cent of carcinomas, clinically, before operation. When the diagnosis is made before operation by the usual signs of rapid growth, fixation, hoarseness, and weight loss the situation is usually out of hand. However, in 50 to 60 per cent of all cases of carcinoma of the thyroid the diagnosis is promptly made in the laboratory, affording the opportunity for adequate and appropriate treatment. The importance of postoperative microscopic examination of all goiters removed, to assure the early discovery of malignancy, has been repeatedly stressed.

The accepted treatment of carcinoma of the thyroid is widespread removal, followed by irradi-

ation with radium and x ray (1, 23, 29, 30) Many of the earlier operations were radical, and the mortality high, but the present trend is to excise only as much tissue as is safely possible, attempting to remove all involved tissue, following which irradiation is carried out. It is now well recognized, I believe, that the various forms of malignant processes attacking this gland require different therapeutic procedures. The plan of operation varying considerably according to the pathologist's histological findings. This has been repeatedly emphasized by Pemberton who has had the largest experience of anyone living in the treatment of this disease.

End results in various types of treatment. Portmann, reporting from the Cleveland Clinic, compared results of various forms of treatment. Operation alone gave 9 per cent 5 year cures. Irradiation alone gave no 5 year cures. Operation plus irradiation yielded 22.6 per cent 5 year cures.

Bowing in 1927 reported a Mayo Clinic series of 167 patients. Of 91 patients treated by operation plus irradiation, 31 per cent were living 5 years or more. Of 76 patients treated with irradiation alone there were 11 per cent 5 year cures.

Pemberton and Fricke in 1933, reported a Mayo Clinic series of 161 cases. Of 107 patients treated by surgery plus irradiation 63 per cent were living and well 5 to 10 years after treatment. In the group remaining the extent of malignancy precluded surgery. Irradiation alone was carried out. Of these 54 per cent died within a year but 10 per cent were living at the end of 5 years.

Pemberton and Dixon, in 1934, gave the Mayo Clinic experience from January 1, 1907 to July 1, 1928. There were 423 patients with cancer who were operated upon. In 56 cases of biopsy, irradiation alone was carried out. The 267 remaining received partial or nearly complete thyroidectomy with or without removal of the cervical lymph nodes. Eleven of the 313 patients died in the hospital, a mortality of 3.4 per cent. Of the 312 patients remaining 44 per cent have lived 5 years or more and nearly 20 per cent lived more than 10 years. Of the 137 patients who lived 5 years or more, the treatment in 7 per cent was irradiation alone and in 93 per cent radical removal with or without postoperative irradiation.

These end results establish two points: (1) the value of the combined surgical removal and irradiation, (2) carcinoma of the thyroid is by no means, the utterly hopeless condition it has been thought to be.

Operability. The operability of carcinoma of the thyroid depends largely upon the judgment of

the surgeon. If the neoplasm is attached to deep structures operation is inadvisable. If, on the other hand, attachment appears to be only at one point, resection may be performed with hope of dissecting the growth away from the involved structure. If the growth is encapsulated enucleation is all that is usually indicated. If some doubt exists as to the presence of extension into the surrounding gland, then the entire lobe should be excised. It is rarely necessary to perform a resection of both lobes. Joll leans to wide resection of muscles, fascia, vessels and nerves, yet the general viewpoint is that very radical operations often do more harm than good and that better results are obtained from the excision of as much tissue as is safely possible followed by irradiation.

Metastasis is not of itself a contra indication to operation. If the primary lesion is resectable the procedure may well be undertaken for many cancers of the thyroid are of a low degree of malignancy, and a patient even with metastasis may live in comfort for some years.

Cervical node extension from an adenocarcinoma of an adenoma is of much graver import than from a papillary carcinoma, for in the former distant metastasis has probably already taken place before local extension occurs.

Diffuse adenocarcinomas are rarely operable.

Irradiation. Carcinoma of the thyroid gland like carcinoma of the ovary, holds a unique position among malignant processes in that while it is usually of a low grade of malignancy it is relatively radiosensitive, this being true especially of the papillary type. It has already been shown that the combination of surgery and irradiation gives the best statistical results. It has been noted by Pemberton and Fricke that 10 per cent of the non operable, apparently hopeless patients treated only with irradiation were living after 5 years.

CONCLUSIONS

We can sum up that the salient features of our present knowledge of this subject are about as follows:

1. While the neoplasm's life history varies markedly from that usually known to be characteristic of malignancy of other organs, yet the essential biological characteristics are the same as with cancer elsewhere. The mystery regarding 'metastasizing benign adenomas' has been thoroughly dispelled. From the investigations of Simpson, Wilson, Crotti, Collier, and many others it is known definitely that benign thyroid tumors do not undergo metastasis and that such extensions as have been considered to be benign are, invariably, carcinomatous.

2. It is established that, while many carcinomas may be readily detected before operation, in many instances the disease is present and unrecognized until the tissue is in the laboratory.

3. It is known, only too well, that, in a large percentage of cases, only under the microscope can the exact diagnosis be made and then only when the examination is conducted by an especially skilled pathologist. In no form of neoplastic disease is error so possible as with early cancer of the thyroid gland. "Of all adenocarcinomas in any situation, I know of none with a wider range of structure than adenocarcinomas of the thyroid. They may be so undifferentiated that they are with difficulty distinguished from sarcomas, and, on the other hand, they may be so well differentiated that they produce structures closely resembling the normal thyroid gland, toxic adenoma or exophthalmic goiter, with the actual production of hyperthyroidism" (Broders).

4. One is led to believe that many reports of high percentages of cures following surgical extirpation of assumed carcinomatous thyroids, have been misleading, due to a fallacious histological diagnosis. On the other hand, from the clinics where the largest series have been studied it is evident that a gratifying percentage of 5 year cures may result from early and total extirpation followed by irradiation. Thus, in what is probably the largest series reported, that of Pemberton, of nearly 700 cases, in which group 267 patients were subjected to partial or complete thyroidectomy, 43.9 per cent lived for 5 years or longer.

5. Of the many complex pathological classifications, the one followed at the Mayo Clinic is simple and adequate: (1) papillary adenocarcinoma, (2) adenocarcinoma in malignant adenomas; (3) diffuse adenocarcinoma; (4) epithelioma; and (5) sarcoma (rare).

6. The high incidence with which carcinoma has developed in pre-existing adenomas is now well recognized and is mentioned by practically all recent writers. It is accepted that probably 85 per cent to 90 per cent of all carcinomas originate in a pre-existing adenoma. From this conclusions have been reached that, while relatively few adenomas become carcinoma, as a prophylactic measure, in view of the extremely low mortality with our present technique, all tumors of the thyroid gland, at least in adults, should be extirpated.

7. While the criterion of vascular invasion as an evidence of malignancy, advanced by Graham, is an interesting viewpoint, it is not entirely accepted, for while such invasion indicates positively a neoplastic process, malignancy of the

thyroid gland exists without such invasion being demonstrable.

8. It is accepted that with the three commoner types of neoplastic thyroid disease there is a wide variation in degree of malignancy. Papillary adenocarcinoma is known to be of a relatively low grade with the tendency to spread by lymphatic invasion. The metastasis usually becomes localized and remains relatively quiescent over a long period of time, resembling, as has been pointed out, the characteristics of papillary adenocarcinoma of the ovary.

9. The relative importance of aberrant thyroid tissue in the production of carcinoma is still an open question. While it is claimed that these are true supernumerary islands of thyroid tissue which are prone to carcinomatous change, it is claimed by others that such lateral aberrant masses are merely metastatic extensions from an original neoplasm within the gland itself.

10. It is accepted that the majority of carcinomas of the thyroid are malignant adenomas or carcinomas, originating in fetal adenomas and papillary adenocarcinomas, diffuse adenocarcinoma being less common and being the most highly malignant form. Within this group falls the fulminating malignant cancer of the thyroid for which so little can be accomplished.

11. Squamous epitheliomas are extremely unusual and sarcoma so rare that its actual existence has been questioned, notably by Ewing.

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CLINICAL CONGRESS TECHNICAL EXHIBITION

LEADING manufacturers of and dealers in surgical instruments, hospital apparatus and supplies, diagnostic and therapeutic apparatus, pharmaceuticals, and publishers of medical and surgical books were represented in the Technical Exhibition at the Stevens Hotel, October 25-29, 1937.

Abbott Laboratories, North Chicago, Ill
W D Allison Co, Indianapolis, Ind
A. S. Aloe Co, St. Louis
American Cystoscope Makers, Inc, New York
American Hospital Supply Corp, Chicago
American Safety Razor Corp, Brooklyn
American Sterilizer Co, Erie, Pa.
D Appleton-Century Co, New York
Armour & Co, Chicago
Aznoe's National Physicians' Exchange, Chicago
C R Bard, Inc, New York
Bard-Parker Co, Danbury, Conn.
Bauer & Black, Chicago
W A Baum Co, Inc, New York
Rudolph Beaver, Inc, Waltham, Mass.
Becton, Dickinson & Co, Rutherford, N J
Bell & Howell Co, Chicago
Bilhuber-Knoll Corp, Jersey City, N. J
Burdick Corp, Milton, Wis
Burrows Co, Chicago
Cameron Heartometer Co, Chicago
Cameron Surgical Specialty Co, Chicago
S H Camp & Co, Jackson, Mich
Wilnot Castle Co, Rochester, N Y
Chappel Laboratories, Rockford, Ill
Chicago Medical Book Co, Chicago
Clay-Adams Co, New York
Warren E. Collins, Inc, Boston
Crane Co, Chicago
Crescent Surgical Sales Co, New York
Cutter Laboratories, Berkeley, Calif
Davis & Geck, Brooklyn
F A Davis Co, Philadelphia
J A Deknatel & Son, Queens Village, N Y
DePuy Manufacturing Co, Warsaw, Ind
Duke Laboratories, Long Island City, N Y
E & J Manufacturing Co, Glendale, Calif.
Eastman Kodak Co, Rochester, N Y.
Electric Storage Battery Co, Philadelphia
Electro Surgical Instrument Co, Rochester, N Y
J H Emerson, Cambridge, Mass
H G Fischer & Co, Chicago
Foregger Co, New York
General Electric X-Ray Corp, Chicago
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Hanovia Chemical & Manufacturing Co, Newark, N J
Fred Haslam & Co, Brooklyn
Heidbrink Co, Minneapolis
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Hospital Liquids, Inc, Chicago

Ille Electric Corp, New York
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Jones Metabolism Equipment Co., Chicago
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Lea & Febiger, Philadelphia
Lewis Manufacturing Co, Walpole, Mass.
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Liebel-Flarsheim Co, Cincinnati
Linde Air Products Co, New York
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Petrolagar Laboratories, Chicago
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W. F. Prior Co, Hagerstown, Md.
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Wilson Rubber Co, Canton, Ohio
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Max Wocher & Son Co, Cincinnati
Year Book Publishers, Chicago
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EFFECT OF SUBCUTANEOUS INJECTIONS OF CONCENTRATED SPLEEN EXTRACT ON MOUSE SARCOMA 180

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IT IS a well known fact that mouse sarcoma 180 is most refractory to any form of treatment and that this tumor shows a very low incidence of spontaneous regressions. Haagensen and Prime state that sarcoma 180 is the most reliable experimental instrument among all transplantable animal tumors with which they are familiar. They use this tumor in preference to any other for testing the therapeutic efficacy of chemical and physical agents on cancer. In reference to the question whether transplantable or spontaneous tumors are preferable for experimental cancer research, these authors conclude that "although new methods have recently been developed by which rat and mouse tumors can be induced with ease, the well known strains of transplantable tumors will continue to be used, for they afford the most convenient means of testing new forms of cancer therapy."

The experiments which are reported in this paper are based on the well known observation that in general abdominal carcinomatosis the spleen is usually free from any metastases. This observation has suggested the idea of using spleen extract in the treatment

From the Laboratories of Mount Sinai Hospital
Read before the New York Pathological Society, October 28, 1937

of human or animal malignancy. Many attempts have been made in this direction (Bauer, Chaletzka, Lyslowa and Schabad; Ludwig and Ries; Aueler; Roskin; and others.) However, they failed to give practical results, probably because, as will be seen in this paper, the concentration was too weak. It seemed to me advisable to use much higher concentrations than had previously been used.

In order to obtain a concentrated spleen extract a number of pharmaceutical houses were approached during the last few years. They were reluctant to experiment along these lines as the results seemed to be problematical.

About 2 years ago I submitted the same problem to Dr. David Klein, chief chemist of the Wilson Laboratories. He consented to prepare concentrated spleen extract. After some months of experimentation I received from him an extract in which 1 cubic centimeter represented 40 grams of beef spleen. Later a more concentrated extract representing 100 grams of spleen per cubic centimeter was made. While the manufacturing process is still being changed, in accordance with the experimental observations in the laboratory, the concentration of 100 grams of spleen in 1 cubic centimeter of extract has

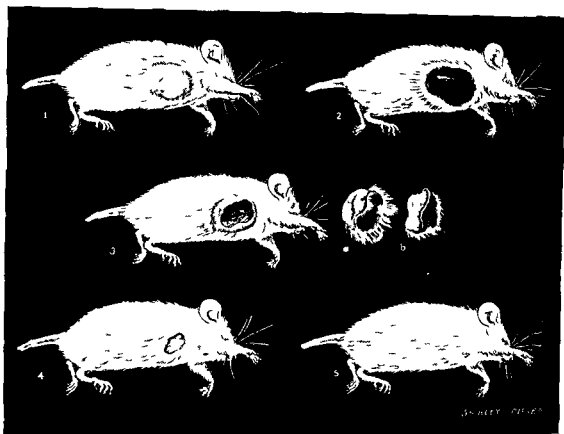


PLATE I 1 Sarcoma 180 2 Hemorrhage 3 Cavity 3a Excluded tumor
3b Cross section of excluded tumor 4 Scab 5 Healed

*Effect of Subcutaneous Injections of Concentrated Spleen Extract on
Mouse Sarcoma 180 — Richard Leisohn*



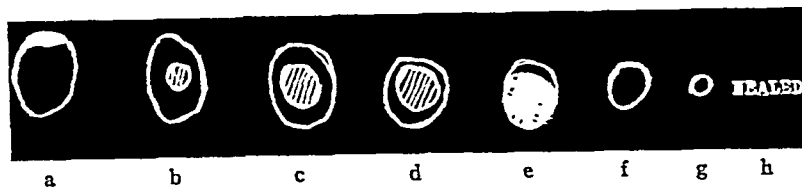


Fig. 1. Different stages of sarcoma 180 treated with concentrated spleen extract.

Tumors treated with concentrated spleen extract, show, after a few injections, palpatory findings entirely different from those in the controls. Whereas the control tumors spread and are broadly attached to the underlying tissues, the tumors treated with extract can be lifted up easily from fascia and muscles. This sign which was often observed before the tumor began to regress was one of the first indications that the tumor would disappear after prolonged treatment with spleen extract.

The time which elapses between the first injection and the complete disappearance of the tumor depends to a marked degree upon the size of the tumor. For instance in the earlier sets (724¹, 738, and 841) the tumors both in the injected and in the control animals were of moderate size. Two or three weeks of

¹Set 724 was treated with a less concentrated extract (.0 gm of spleen in 1 c cm). This set is not included in the statistics which deal only with the more concentrated extract (100 gm. of spleen in 1 c cm.).

injections were required to make the tumor in the injected mice disappear completely. On the other hand in the more recent sets (897, 898, and 899 [Tables III and IV], 990, 991, and 992, and later sets) which had developed very large tumors both in the animals which were selected for the injections and in the controls, 4 to 6 weeks elapsed before no trace of tumor was left.

The tumors have not recurred during an observation time of up to 5 months. A number of animals died recently of natural causes. Careful microscopic examination of the region where the tumor had been located failed to show any traces of tumor cells, except in one case in which a small remainder of tumor was found. We used to stop injections after the macroscopic disappearance of the tumor. We now continue injections for 2 to 3 weeks after inspection and palpation fail to show a trace of the tumor.

TABLE II.—REVIEW OF SETS TREATED WITH SPLEEN EXTRACTS WITH CORRESPONDING CONTROLS

Tumor mice treated with spleen extract				Controls			
No	Set	Number of treated mice	Number of healed mice	No	Set	Number of treated mice	Number of healed mice
1	738	6	4	1	749	10	1
2	841	9	6	2	849	9	2
3	897-899	20	13	3	900	20	1
4	990-992	20	9	4	993	20	4
5	96-104	42	21	5	97-102	42	0
6	106-107	20	14	6	108-109	20	1
7	116-117-119	30	14	7	120-121	30	0
8	124-125	17	12	8	127-129	17	1
9	135-136	20	11	9	134-137	20	2
10	154-157	35	20	10	159-160	35	2
11	170-183	42	32	11	184-186	42	8
12	193-194	20	14	12	195-197	25	1
		281	170 60 per cent			290	23 8 per cent

been maintained. The action of this concentrated spleen extract on sarcoma 180 is the basis of this report.

The extract is an aqueous product prepared by extracting with water, adsorption with activated carbon, triple extraction with alcohol and elution. It represents 100 grams of fresh spleen tissue per cubic centimeter.

Cultures of the extract are sterile both aerobically and anaerobically.

Healthy looking female mice of the Rock land farm strain weighing 18 to 20 grams were selected for the experiments. A strain of mouse sarcoma 180 originally received from the Crocker Laboratory was used for transplantation. Small tumor particles were introduced into the right axilla with a trocar. Every tumor was cultured before the transplantation. Before the experiments were started a certain percentage of animals were killed and cultures were taken in order to rule out infection. Furthermore whenever controls showed a percentage of regressions higher than the normal level, cultures were taken in order to exclude regression by infection.

REPORT OF EXPERIMENTS

Two hundred eighty-one animals with sarcoma 180 were treated with subcutaneous injections of 0.5 cubic centimeter of concentrated spleen extract. Two hundred ninety animals were used as controls. Eighty animals (20 in each series) were treated with other organ extracts (heart, liver, pancreas

and testis). Fifty nine animals were given smaller doses of spleen extract (0.1 c cm). Twenty animals were injected with chlorobutanol and 20 with merthiolate in the same percentage as used in the spleen extract and the other organ extracts (Table I). In order to prepare the charts for this presentation, the records were carried up to October 15, 1937.

The number of animals used in each set for injections with spleen extract and for controls is shown in Table II.

The injection (0.5 c cm) was given subcutaneously as far away as possible from the tumor. The tumor was situated near the right axilla, the injections were given into the subcutaneous tissue near the left hip joint. There was no sign of local irritation, inflammation, or infection found at the site of injection.

The first injection was given 7 to 9 days after the transplantation depending upon the size of the tumor (Fig 1a). In about 30 per cent of the tumors a marked hemorrhage was noted in less than 24 hours following the injection of the extract. In the majority of cases the hemorrhage did not occur until three or four subcutaneous injections had been given on 3 or 4 consecutive days (Fig 1b). However, in a number of animals this hemorrhage was observed within a few hours after the injection. This hemorrhage into the tumor gradually increased in size, when the injections were continued daily (Fig 1c). Ultimately the tumor consisted of a large hemorrhagic center (Fig 1d) surrounded by a narrow wall of tumor tissue. Subsequently a scab was noticed in the area which was formerly represented by the hemorrhage. When this stage was reached the tumor either stopped growing or began to diminish in size. Gradually the hemorrhagic scab was expelled, leaving a large cavity. This cavity eventually broke through the encircling tumor tissue, leaving a half moon like ring of tumor (Fig 1e). The cavity decreased in size in a few days the half moon like ring of tumor tissue was absorbed (Fig 1f) and after a few weeks the tumor not only disappeared completely, but the area where it had been located presented an absolutely normal appearance except for a slight alopecia (Figs 1g and 1h).

TABLE I—PEVIEW OF MATERIAL

	Number	Per cent	Total Number
Injections of 0.5 c cm spleen extract			281
Tumor disappeared	170	60	
Corresponding controls			290
Spontaneous regressions	23	8	
Injections of 1 c cm spleen extract			59
Regressions	1	3	
Spontaneous regressions among corresponding controls	3	5	
Injection with other organ extracts—heart liver pancreas testis			80
Regressions	7	8	
Spontaneous regressions among corresponding controls	7	8	
Injection of antiseptics used in spleen extracts—chlorobutanol 0.25 per cent merthiolate 1:200,000	20 each		40
Regressions	0		
Total			750

Set 99 Female Rockland mice. Sarcoma 180 Jan 20, 1937

House	Jan 23	Jan 29	Feb 1	Feb 4	Feb 9	Feb 15	Feb 18	Feb 25
1	○	○	+					
2	○	○	○	+				
3	○	○	○	○	+			
4	○	○	○	○	○	+		
5	○	○	○	○	○	+		
6	○	○	○	○	○	+		
7	○	○	○	○	○	○	+	
8	○	○	○	○	+			
9	○	○	○	○	○	○	+	
10	○	○	○	○	○	○	+	
11	○	○	○	○	○	○	+	
12	○	○	○	○	+			
13	○	○	○	○	○	+		
14	○	○	○	○	○	○	+	
15	○	○	○	○	+			
16	○	○	○	○	○	+		
17	○	○	○	○	+			
18	○	○	○	○	○	○	+	
19	○	○	○	○	○	○	+	

Table V Set 901 Controls for 897, 898, and 899

statement An inspection of the charts demonstrates very clearly that in spite of large ulcerations with secondary infections tumors in the controls continue to grow and ultimately cause the death of the animals. The process which is observed in the *treated* animals is entirely different. We do not notice the secondary infection, but we observe that the hemorrhagic area is excluded. The field appears completely dry contrary to the marked secretion which accompanies the ulcerative process in the controls.

In order to ascertain the specificity of concentrated spleen extract for the treatment of mouse sarcoma 180, four other organ extracts were tested, namely, liver, heart, pancreas, and testis. All these organs were obtained from the same animal as the spleen (beef). The extracts were identical in concentration and preparation with the spleen extract. It is of the greatest interest to know that none of these caused hemorrhages or retarded the growth of the tumors (Tables XII to XV).

Treated ♀ Rockland mice

Sarcoma 180

Transplanted Line 30 1937

1st injection, set 95 98 101 102 - July 9 1937

1st injection, set 104 - July 12

House	July 9	July 12	July 15	July 18	July 21	July 24	July 27	July 30	Aug 2	Aug 5	Aug 8	Aug 11	Aug 14	Aug 17	Aug 20	Aug 23	Aug 26	Aug 29	Sept 1	Sept 4	Sept 7	Sept 10	Sept 13	Sept 16	Sept 19	Sept 22	Sept 25	Sept 28	Sept 30	Oct 3	Oct 6	Oct 9	Oct 12	Oct 15	Oct 18	Oct 21	Oct 24	Oct 27	Oct 30	Nov 2	Nov 5	Nov 8	Nov 11	Nov 14	Nov 17	Nov 20	Nov 23	Nov 26	Nov 29	Dec 2	Dec 5	Dec 8	Dec 11	Dec 14	Dec 17	Dec 20	Dec 23	Dec 26	Dec 29	Jan 1 1938	Jan 4	Jan 7	Jan 10	Jan 13	Jan 16	Jan 19	Jan 22	Jan 25	Jan 28	Jan 31	Feb 3	Feb 6	Feb 9	Feb 12	Feb 15	Feb 18	Feb 21	Feb 24	Feb 27	Feb 29	Mar 2	Mar 5	Mar 8	Mar 11	Mar 14	Mar 17	Mar 20	Mar 23	Mar 26	Mar 29	Mar 31	Apr 3	Apr 6	Apr 9	Apr 12	Apr 15	Apr 18	Apr 21	Apr 24	Apr 27	Apr 30	May 3	May 6	May 9	May 12	May 15	May 18	May 21	May 24	May 27	May 30	Jun 2	Jun 5	Jun 8	Jun 11	Jun 14	Jun 17	Jun 20	Jun 23	Jun 26	Jun 29	Jul 2	Jul 5	Jul 8	Jul 11	Jul 14	Jul 17	Jul 20	Jul 23	Jul 26	Jul 29	Aug 1	Aug 4	Aug 7	Aug 10	Aug 13	Aug 16	Aug 19	Aug 22	Aug 25	Aug 28	Aug 31	Sep 3	Sep 6	Sep 9	Sep 12	Sep 15	Sep 18	Sep 21	Sep 24	Sep 27	Sep 30	Oct 3	Oct 6	Oct 9	Oct 12	Oct 15	Oct 18	Oct 21	Oct 24	Oct 27	Oct 30	Nov 2	Nov 5	Nov 8	Nov 11	Nov 14	Nov 17	Nov 20	Nov 23	Nov 26	Nov 29	Dec 2	Dec 5	Dec 8	Dec 11	Dec 14	Dec 17	Dec 20	Dec 23	Dec 26	Dec 29	Jan 1 1938	Jan 4	Jan 7	Jan 10	Jan 13	Jan 16	Jan 19	Jan 22	Jan 25	Jan 28	Jan 31	Feb 3	Feb 6	Feb 9	Feb 12	Feb 15	Feb 18	Feb 21	Feb 24	Feb 27	Feb 29	Mar 2	Mar 5	Mar 8	Mar 11	Mar 14	Mar 17	Mar 20	Mar 23	Mar 26	Mar 29	Mar 31	Apr 3	Apr 6	Apr 9	Apr 12	Apr 15	Apr 18	Apr 21	Apr 24	Apr 27	Apr 30	May 3	May 6	May 9	May 12	May 15	May 18	May 21	May 24	May 27	May 30	Jun																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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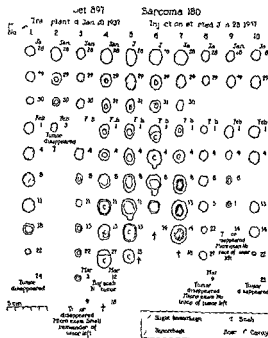


Table III Set 897 Results in 10 treated animals

Control mice show a marked loss of weight in spite of the rapidly growing tumor whereas mice treated with spleen extract often begin to gain weight long before the tumor has actually disappeared (see charts). This gain in weight is sometimes the first indication that the tumor is about to regress. The weight gain continues after complete disappearance of the tumor.

Tables III to XI inclusive, present graphically the characteristic progress and final effect of some of the individual experiments. The full tabulation of the results is presented in Table II. It is evident from this table that of 281 animals treated with spleen extract the tumors disappeared in 170 cases (60 per cent). Of 290 animals used as controls only 23 (8 per cent) showed spontaneous regressions.

Sets of treated animals were not included in the statistics when the controls showed a high percentage of regressions. It is interesting to point out that the number of cures among the treated animals rises when the controls show a high percentage of regressions. For instance in one set in which the controls

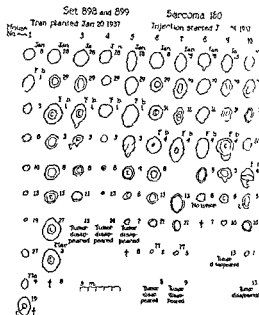


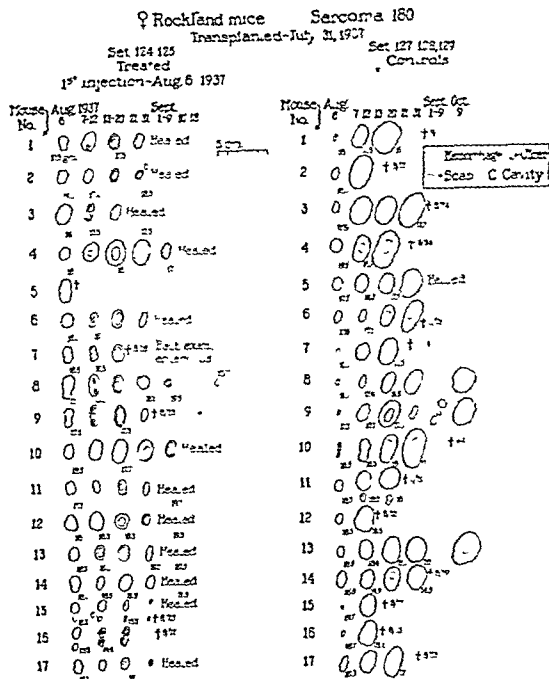
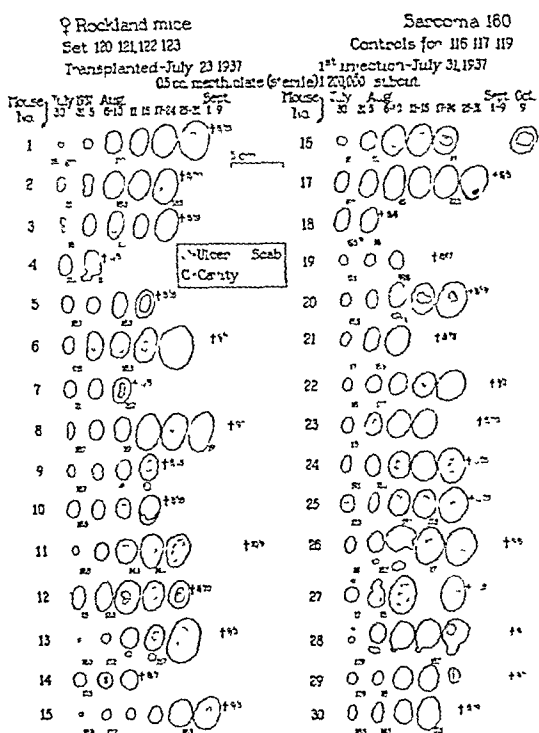
Table IV Sets 898 and 899 Results in 10 treated animals

showed 30 per cent regressions, the percentage of cures among the treated animals rose to 85 per cent.

We have confined our statistical survey to those animals whose tumors disappeared completely. We did not include a large group of mice (over 30 per cent) whose tumors showed regression or arrest of growth, but which died before the injections could be completed.

Two forms of spontaneous regressions were observed in the controls. First, early regression was observed in those tumors which showed an ulceration a short time after the transplantation namely on the sixth or seventh day. Some days later a few of these tumors showed a cavity. Their growth was arrested and they disappeared after the fourteenth day. Second, late regression was observed in a few animals which did not succumb to the rapidly growing tumor in 4 to 6 weeks. In this group an infection of the tumor could be observed which caused its disappearance.

It has been stated that any transplantable tumor is apt to disappear spontaneously in the presence of an ulceration. My experience with sarcoma 180 is at variance with this



Dr R Leuchtenberger has performed in this laboratory some very interesting experiments with histamine which have not yet been concluded. Therefore we shall report them in detail in a later publication. However, I may state now that, following subcutaneous injections of histamine, early hemorrhages occur in these tumors (sarcoma 180) which are identical in appearance with those observed following the subcutaneous injection of spleen extract. Histamine is Schwartzman-negative. Thus we find that two Schwartzman-negative substances (spleen extract and histamine) may effect hemorrhages into sarcoma 180.

Whereas small doses of spleen extract stimulate the growth of the tumors, large doses of histamine seem to have a stimulating effect upon sarcoma 180.

In its present form and application the extract does not cause disappearance of the tumor after a few injections. To effect a complete regression it usually requires injections

of 0.5 cubic centimeter extending over 3 to 6 weeks.

The mortality following the injection among animals injected with spleen extract depends to a large degree upon the proper gauging of the injections. If these are given routinely day after day without attention being paid to the state of health of the animal, the mortality is apt to be relatively high. However, if due care is taken to individualize the frequency of the injections according to the condition of the mouse, the mortality is reduced considerably.

Furthermore it should be pointed out that proper food and good care of the animals are of the utmost importance in reducing their mortality. In the earlier series we lost a considerable number of animals during the course of the treatments. Since proper attention was paid both to the frequency of the injections and the proper feeding, the mortality has been markedly lessened.

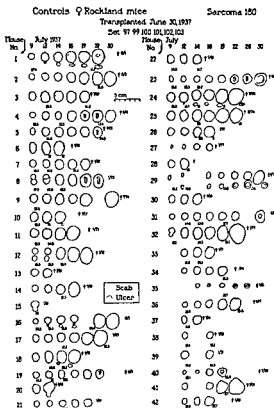


Table VII

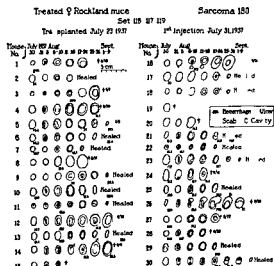


Table IX

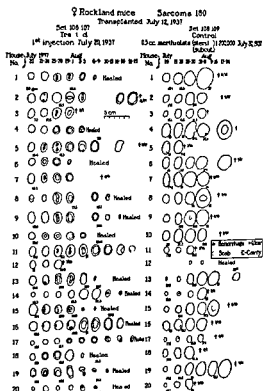


Table VIII

Table VII Sets 97 to 103 Controls for 96 to 104 Forty two animals 42 dead

Table VIII Sets 106 to 108 Twenty treated animals with 20 controls Note No 14 weight gain from 18.3 grams to 21.5 grams in spite of progressive growth of tumor Subsequent cure

Table IX Sets 116 to 119 Thirty treated animals Note weight gains No 6 from 14.5 to 22.5 grams No 30 from 17 to 21.5 grams and others

spleen extract might be due to the presence of a Schwartzman active substance

Through the courtesy of Dr Schwartzman the spleen extract was tested for the Schwartzman phenomenon The extract did not show the phenomenon This negative finding is of considerable importance as it proves that Schwartzman negative substances may cause hemorrhages into malignant tumors Apitz's statement that "all Schwartzman active substances and—according to experiences collected up to-date these substances only—cause hemorrhages into carcinoma" requires correction



Fig 2 Set 183, sarcoma 180, 4 hours after injection of spleen extract



Fig 3 Set 183, sarcoma 180, 24 hours after injection

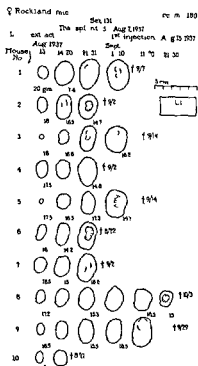


Table XII Animals treated with liver extract

We expect to obtain a more rapid action and a higher percentage of cures by increasing the concentration of the extract and by further attempts to isolate the active principle

Microscopic examinations of the various phases during the treatment were performed by Dr Klemperer. Figure 2 represents the hemorrhagic phase as seen 4 hours after the first injection. Conspicuous dilatation of the blood vessels near the surface and superficial necrosis are noticed. In Figure 3, 24 hours after injection, extensive necrosis of the tumor is seen. The periphery still shows viable tumor. Figure 4, 48 hours after injection, shows almost complete necrosis and necrobiosis of the tumor with the exception of small nests of viable tumor cells at the periphery. The high power microphotogram (Fig 5) shows cytologic details of the same phase. Tumor cells are shrunken, the nuclei are pyknotic, the cytoplasm is eosinophilic and glassy compared with the untreated sarcoma 180 (Fig 6) which shows the cells basophilic

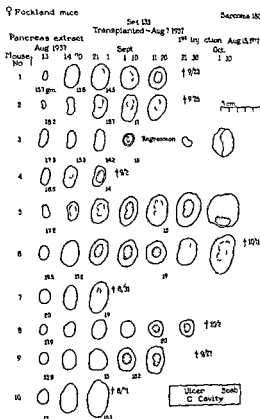


Table XIII Animals treated with pancreas extract

and finely granular. Figure 7, 11 days after the first injection, shows extensive and complete coagulation necrosis of the tumor. Cell ghosts are still present, chiefly at the periphery, mingled with these, occasional viable tumor cells are noted. Figure 8, control, 3 weeks old, shows also necrosis in the center. However, extensive areas of viable tumor cells are observed at the periphery. These microscopic studies are supplementary only to the much more striking gross observations of the fate of the tumor under treatment.

Of greatest interest is the observation that whereas the extract when administered in 0.5 cubic centimeter doses causes disappearance of the tumor in 60 per cent of the cases, the smaller dose of 0.1 cubic centimeter of the same extract has a markedly stimulating effect (Tables XVI and XVII). The tumors



Fig 4 Set 200, sarcoma 180, 48 hours after injection (low power)

grow very rapidly, in fact much more rapidly than the controls. The animals show a very acute loss of weight. After a few injections they change from healthy looking normal mice into completely emaciated and very sick looking animals. This most interesting obser-

vation may explain the contradictory reports given by other authors on the action of spleen extract on malignant tumors. Their failures to get results must have been caused by the fact that they used stimulating doses of spleen extract.

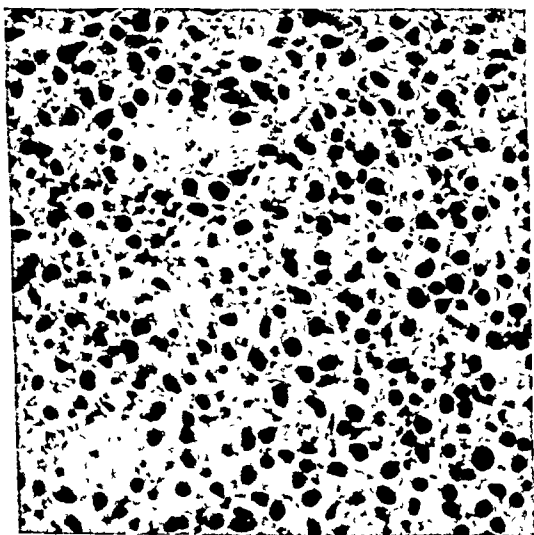


Fig 5 Set 200, same as Figure 4 (high power)

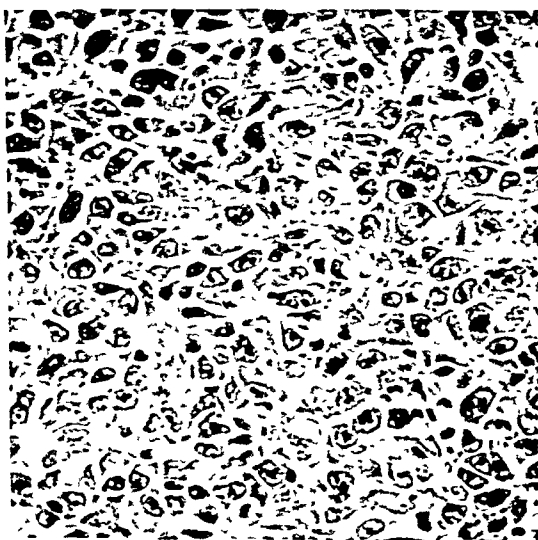


Fig 6 Microscopic section of untreated sarcoma 180



Fig 9 a and b, Spleen in animal treated with spleen extract, c, control

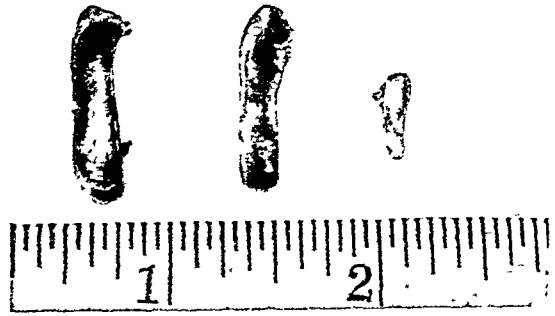


Fig 10 a and b, Spleen in animal treated with spleen extract, c, animal treated with pancreas extract

extracts (liver, pancreas, heart, and testis) is small, whereas after treatment with spleen extract the spleen is very large—often 4 to 5 times the normal size (Figs 9, 10, 11). The large size of the spleen following treatment with concentrated spleen extract suggests the possibility that the therapeutic effect of this extract is not caused by its direct action on the tumors, but by an indirect action via the spleen of the mouse. In other words, it is possible that by increasing the normal defense action of the spleen against malignancy we may retard the growth of the tumor and cause its disappearance. The marked enlargement of the spleen also suggests a possible application of the extract in the treatment of splenic diseases.

Experiments have been started to investigate whether spleen extract has a preventive action upon the growth of the tumor.

Before closing I wish to mention very briefly some recent experiments which I shall report in detail at a later date. They seem of sufficient importance to warrant a brief note. (1) When injections were started on the twelfth day after transplantation instead of on the seventh or eighth day, the process of healing was markedly accelerated and the percentage of cures increased. (2) When 0.1, 0.15, or 0.2 cubic centimeter of the extract is given intravenously, a hemorrhage does not occur. However the other stages (cavity and scab) are noted. We observed a marked regression or complete disappearance of the tumor. The

intravenous approach will now be tested on a large series of animals.

Sarcoma 180 is not supposed to cause metastases. However, we have noted intraperitoneal and other metastases following injections of 0.1 cubic centimeter of spleen extract, of pancreatic extract, and of histamine.

In the small percentage of refractory cases which do not show any response to treatment we have observed in practically every case the presence of intestinal parasites. Domagk has pointed out the possibility of a stimulating effect of these parasites on tumor growth.

Hemorrhages and regressions were noted in rat sarcoma 39 following treatment with spleen extract. However, as we had a fairly high incidence of regressions in the controls, and as the number of animals was small, we cannot at present draw any definite conclusions as to action of extract on sarcoma 39.

The extract will be tried in leucemic mice as it may be of value in some blood diseases.

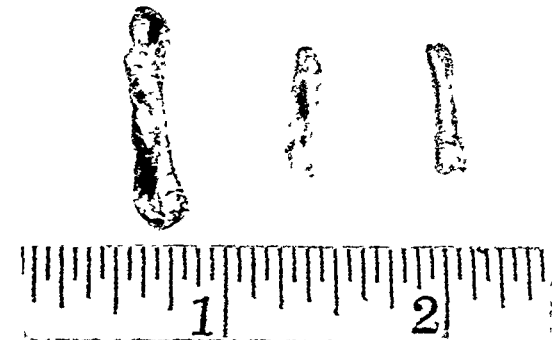


Fig 11 a, Spleen in animal treated with spleen extract, b, animal treated with testicular extract, and c, control.



Fig 7 Set 193 sarcoma 180 11 days after injection



Fig 8 Set 196 control after 3 weeks

Injections of spleen extract at present on the market containing 5 grams of extract per cubic centimeter do not hinder the growth of the tumor. On the contrary they stimulate it

A possible lead to the action of the spleen extract upon the tumor may be found in the following observation. The spleen in the controls and in animals treated with other organ

MALIGNANT ADENOMA OF THE THYROID

Local Recurrences in the Veins of the Neck

ALLEN GRAHAM, M.D., F.A.C.S., Cleveland, Ohio

AN outstanding and well known peculiarity of carcinomas of the thyroid, especially carcinomas of the malignant adenomatous type, is the tendency of the tumor tissue to perforate into the small, thin walled veins in the tumor and the intraluminal propagation and extension of the tumor tissue to the capsular veins, the main thyroid veins, and thence to the jugular veins and even to the vena cava.

During the course of primary operations as usually practiced for the removal of such tumors, it is inevitable that many branches of the thyroid veins and the main trunks will be clamped, divided, and ligated. If perchance tumor tissue be present in the lumina of the veins between the site of ligation and the vena cava, it is obvious that not all the tumor tissue will be removed by the operation and it is more than probable that the patient will have recurrences or metastases which will be beyond further successful surgical intervention.

On the other hand, should tumor tissue be present in the lumina of the veins only distal to the site of ligation, that is, between the ligature and the peripheral distribution of the venous trunks, the very fact of ligation might tend to prevent or delay embolic dissemination of the tumor to the lungs and elsewhere, but would probably have little or no influence upon the further growth of tumor tissue which might remain in such an isolated venous segment. The growth of such a supposititious remnant of tumor tissue, confined to an isolated venous segment, might well account for the reappearance of nodules in the neck some months or even years after the original operation without evidence of distant metastases.

Failure to recognize or properly to interpret this postoperative sequel may lead to a pro-

longed struggle with repeated recurrences, repeated operations, dissemination of the tumor in the neck beyond the possibility of successful surgical removal, and termination of the struggle, after some years of hopeful expectancy, by death of the patient.

If, on the other hand, the possibility of such an occurrence be understood and kept in mind and appropriate surgical treatment be instituted in such cases, it will be possible to vouchsafe years of freedom from trouble for some patients and may perhaps result in a cure in a few instances. The following case reports are illustrative:

CASE REPORTS¹

CASE 1. An unmarried Jewish female, 18 years of age, was admitted to the hospital October 28, 1919, complaining of goiter and tonsillitis. The family history was irrelevant except that the mother had goiter. The patient had had frequent attacks of tonsillitis, the last terminating as a quinsy which ruptured spontaneously.

Two years before admission she noticed a gradual enlargement of the neck which had increased more rapidly during the last 8 months, following the taking of thyroid tablets. She had had some difficulty in swallowing, especially when she had a cold, but there was no history of tachycardia, palpitation, weakness, hyperhidrosis, unusual nervousness, or loss of weight. Her general health had been good.

On examination there were found no eye signs suggestive of hyperthyroidism. The tonsils were enlarged, congested, and protruded slightly. There was moderate bilateral enlargement of the thyroid which was more prominent on the left with numerous rounded, firm tumor masses scattered through the gland. The pulse was regular, rapid, and rhythmic. There was a slight tremor of the fingers.

The primary operation was performed October 30, 1919. Multiple discrete adenomas were found in the right lobe and these were removed by sharp dissection together with a small amount of adjacent thyroid tissue. The left lobe was not disturbed.

Macroscopical examination. The tissue sent to the laboratory consisted of four thinly encapsulated

¹Only positive or pertinent information is recorded, many negative findings being omitted from the case reports. The author will gladly furnish further details to those interested.

From the Department of Surgical Pathology of the Cleveland Clinic.

Read at the meeting of the American Association for the Study of Goiter, Detroit, Michigan, June 16, 1937.

Reports on experiments with trypanblue and on the action of spleen extract on splenectomized tumor animals will be presented in later publications

SUMMARY

1 Of 281 animals treated with subcutaneous injections of 0.5 cubic centimeter of concentrated spleen extract (100 gms of fresh spleen in 1 c cm) the tumor (sarcoma 180) disappeared completely in 170 animals (60 per cent)

2 Corresponding controls showed a spontaneous regression in 8 per cent of 290 animals

3 Injections extending usually over 2 to 6 weeks, depending upon the original size of the tumors, are required to cause disappearance of the tumors

4 Weight gain is an early sign indicating subsequent disappearance of the tumor

5 Small doses of the extract (0.1 c cm) have a stimulating effect upon the tumor

6 A marked increase in the size of the spleen is noted in the animals treated with

spleen extract. Animals treated with other organ extracts and controls do not show this enlargement

7 Extracts from the liver, heart, pancreas, and testis fail to cause hemorrhages into the tumor or to influence its growth

8 The spleen extract does not show the Schwartzman phenomenon

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CASE 1 An unmarried Jewish female, 18 years of age, was admitted to the hospital October 28, 1919, complaining of goiter and tonsillitis. The family history was irrelevant except that the mother had goiter. The patient had had frequent attacks of tonsillitis, the last terminating as a quinsy which ruptured spontaneously.

Two years before admission she noticed a gradual enlargement of the neck which had increased more rapidly during the last 8 months, following the taking of thyroid tablets. She had had some difficulty in swallowing, especially when she had a cold, but there was no history of tachycardia, palpitation, weakness, hyperhidrosis, unusual nervousness, or loss of weight. Her general health had been good.

On examination there were found no eye signs suggestive of hyperthyroidism. The tonsils were enlarged, congested, and protruded slightly. There was moderate bilateral enlargement of the thyroid which was more prominent on the left with numerous rounded, firm tumor masses scattered through the gland. The pulse was regular, rapid, and rhythmic. There was a slight tremor of the fingers.

The primary operation was performed October 30, 1919. Multiple discrete adenomas were found in the right lobe and these were removed by sharp dissection together with a small amount of adjacent thyroid tissue. The left lobe was not disturbed.

Macroscopic examination The tissue sent to the laboratory consisted of four thinly encapsulated

¹Only positive or pertinent information is recorded, many negative findings being omitted from the case reports. The author will gladly furnish further details to those interested.

From the Department of Surgical Pathology of the Cleveland Clinic.

Read at the meeting of the American Association for the Study of Goiter, Detroit, Michigan, June 16, 1937.

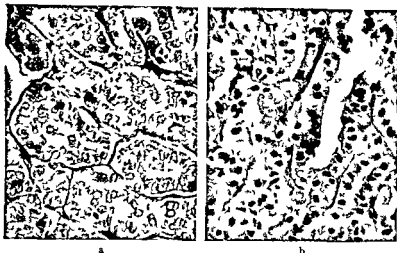


Fig 1 Case 1 a Primary tumor from the right lobe of the thyroid b Recurrence in the right lobe 1 year later $\times 250$

firm nodules having a very cellular grayish opaque cut surface and there was a moderate amount of hyperplastic non tumorous thyroid

Microscopical examination Sections from some of the nodules showed the absence of a definite lobular arrangement rather thick capsular zones and tumor tissue composed of acini of normal size or smaller which were closely packed together and were lined with a single layer of high cuboidal epithelial cells. There was no colloid material (Fig 1a). Sections from other nodules showed larger acini which were filled with dark pink staining colloidal material and were lined with low cuboidal cells.

A pathological diagnosis of multiple fetal adenomas was made.

The patient made an uneventful recovery and was discharged from the hospital 8 days after the operation.

Tonsillectomy was performed December 1, 1919. October 17, 1920, one year following the primary operation, the patient was readmitted to the hospital because of the recurrence of a nodule in the neck unassociated with symptoms. On examination the previous operative scar was scarcely visible. There was no lymphadenopathy. There was a small hard irregular painless tumor about the size of a walnut situated to the right of the thyroid cartilage and not attached to the skin.

The second operation was performed October 20, 1920. There were adhesions between the gland and the muscles but these were not dense. A small adenoma was situated directly over the larynx and there were thought to be multiple adenomas in the right lobe. The right lobe isthmus and part of the left lobe were removed.

Macroscopical examination The tissue removed consisted of the major portion of both lobes and isthmus of the thyroid. The weight of this tissue was 30 grams. The left lobe and isthmus consisted of colloid thyroid tissue without adenomatous nodules. The portion of right lobe was occupied by a non encapsulated infiltrating tumor mass with a fairly cellular somewhat granular periphery and a more fibrous center. Grossly the tumor appeared to be a carcinoma.

Microscopical examination Sections from the left lobe showed non tumorous colloid thyroid tissue. Sections from the tumorous portion of the right lobe showed strands and columns of atypical epithelial cells lying in a fairly dense connective tissue stroma and having no tendency to form acini. The epithelial cells varied considerably in

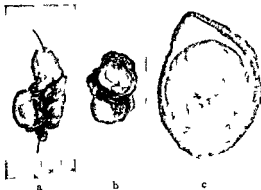


Fig 2 Case 1 a Recurrence in the left jugular vein b Thread passed through the lumen of the vein c The resected jugular vein showing tumor thrombus in the lumen c Cross section of the vein showing tumor thrombus attached to the wall low power photomicrograph $\times 4$

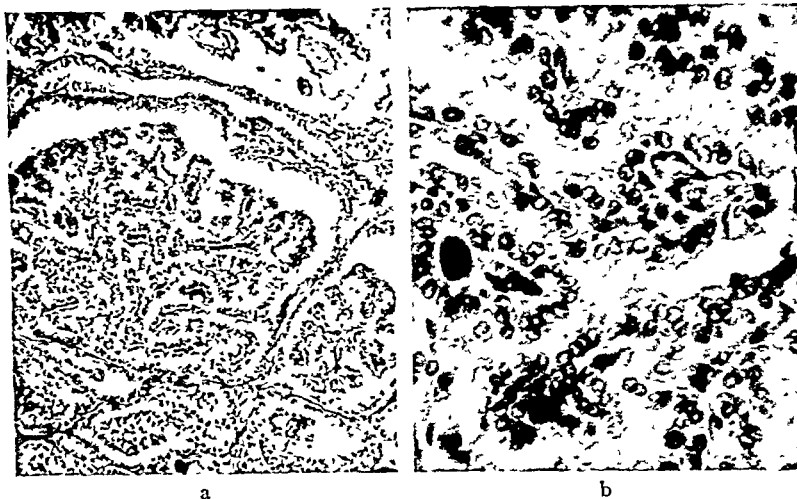


Fig 3 Case 1 a, Adenopapilliferous recurrence in the jugular vein removed approximately 9 years after excision of the first recurrence $\times 50$ b, Higher magnification of the same $\times 250$

size and shape. Many of the nuclei were hyperchromatic, and mitotic figures were moderately abundant (Fig 1b). Sections from the non-tumorous part of the right lobe showed normal appearing thyroid tissue rich in colloid.

A pathological diagnosis of adenocarcinoma (malignant fetal adenoma) was made.

In view of the recurrence in the right lobe and the pathological diagnosis of carcinoma, radium treatment, 1500 milligram hours, was given while the patient was in the hospital. Mild symptoms of tetany developed and were controlled by means of calcium lactate and parathyroid extract. Otherwise the patient made an uncomplicated recovery and was discharged from the hospital 11 days following the second operation.

She was again seen April 25, 1921. There were one or two hard, firm, somewhat movable nodules about the size of hickory nuts in the left thyroid area. These were thought to be recurrences of the malignant tumor. On May 3 and 17, 1921, radium treatments of 900 and 950 milligram hours, respectively, were given over the left lobe of the thyroid.

In August, 1921, the mass in the left thyroid region was smaller. It was palpable but not visible.

During the ensuing 8 years the patient was under observation many times and was treated for various conditions unrelated to the goiter. In May, 1926, 6½ years after the second operation, she thought that the mass in the left thyroid region had become larger but examination at that time failed to confirm this. In March, 1927, she was married.

In September, 1929, 10 years after the primary operation and 9 years after the second operation, despite the fact that there had been no clinically detectable change in the nodule in the left thyroid area, the question of its removal came up for recon-

sideration. In view of the recurrence following the primary operation, the pathological diagnosis of carcinoma made at the time of the second operation, and the apparent recurrence and persistence of a mass following the second operation, it was deemed advisable to remove the mass.

The third operation was performed September 19, 1929. Under nitrous oxide-ether anesthesia, an incision was made along the border of the left sternomastoid muscle and the muscle was retracted mesially. A tumor mass was encountered in the region of the carotid sheath and appeared to be situated in the internal jugular vein. The vein together with the tumor mass was excised between clamps and the cut ends of the internal jugular vein were ligated.

Macroscopic examination. The weight of the tissue removed was 10 grams and it measured 4 by 2.5 by 2 centimeters. The anterior and lateral surfaces were covered by muscle, fascia, and fat. The mesial surface consisted of part of a vein wall and the capsule of the tumor (Fig 2a). The superior extremity of the mass consisted of a vein 7 millimeters in diameter (Fig 2b) which extended along the mesial surface of the mass for a distance of 3 centimeters. The entire venous segment was apparently filled with a solid, pseudolobulated, firm, white tissue containing very little colloid (Fig 2c). The inferior end of the venous segment appeared free from tumor thrombus and was 8 millimeters in diameter. Numerous other venous tributaries were filled with tumor tissue.

Microscopic examination. Sections revealed numerous large venous trunks filled with a tumor mass which consisted of an adenopapilliferous type of thyroid tissue (Fig 3a) showing a well marked tendency to form acini which contained varying



Fig. 4 Case 2 Site of local recurrence 5½ years after the primary operation

amounts of colloidal material. The epithelial cells lining the acini were cuboidal to high columnar in type and mitotic figures were not seen (Fig. 3b).

A pathological diagnosis of malignant adenoma, toxic thyroid tissue recurrent in the jugular vein was made.

The patient made an uneventful recovery and was discharged from the hospital on the seventh post-operative day.

The patient was last heard from in April 1936, 16½ years after the primary operation, 15½ years after the second operation, and 6½ years following the third operation at which time she was free of clinical evidence of malignant disease. Following the third operation (1929) symptoms of hypothyroidism developed and were controlled by means of thyroid extract.

In this case it is apparent from the record that, at the time of the primary operation, malignancy was not suspected before or during the operation, nor on gross and microscopic examination of the tissue removed. The operation consisted of shelling out four encapsulated nodules, presumably fetal adenomas from the right lobe and excision of a part of the lobe. One year later, the patient returned with a nodule in the right side of the neck, which was thought to be a regrowth of an incompletely removed adenoma or further growth of an adenoma which was not discovered during the primary operation. During the operation for the removal of the recurrence in the right lobe, malignancy was not

suspected. A large part of the right lobe with the tumor, the isthmus, and a part of the left lobe were removed. On gross and microscopic examination the pathologist suspected malignancy and made a diagnosis of adenocarcinoma involving the right lobe only. About 6 months after the second operation, the patient returned with a mass in the left side of the neck, which was interpreted as a contralateral recurrence or metastasis and was treated with radium. The mass decreased in size but persisted and after several years having gained experience in several other cases which strongly suggested the possibility, it was thought quite possible that this mass in the left side of the neck might be confined within veins and that operative removal might prevent dissemination. The operation was undertaken with this possibility in mind, under surgical anesthesia, with adequate exposure, every effort being made to keep beyond the limits of the growth and to remove involved veins if possible. This is the first case in which it was proved to the entire satisfaction of the writer that the local growth was in the jugular vein. The subsequent course apparently warrants the assumption that there was no other recurrence or metastasis.

CASE 2. A white male 55 years of age registered in the clinic September 26, 1925, complaining of goiter. The family history was essentially negative. The patient had had pneumonia and his appendix had been removed 11 years previously.

A goiter which had been present for 25 years had gradually increased in size and grown more rapidly during the last 2 years and was accompanied by definite symptoms of pressure such as difficulty in swallowing solid foods and difficulty in breathing when the head was in certain positions. He had been somewhat nervous for 4 to 5 years and slightly dyspneic on exertion for 2 or 3 years. He had had no palpitation or loss of weight.

On examination the pulse was found to be 100, blood pressure 125 systolic and 80 diastolic. There was a large adenomatous goiter. The right lobe was greatly enlarged and contained one nodule the size of an orange and another about the size of an egg. Both were quite hard, firmly fixed and did not move on swallowing. The left lobe was also enlarged and contained several small discrete nodules the size of a hickory nut or less. None of the cardinal symptoms or signs of hyperthyroidism were noted.

A clinical diagnosis of adenomatous goiter with possible malignancy was made.

The primary operation was performed September



Fig 5 Case 2 Recurrence in the jugular vein excised $5\frac{1}{2}$ years after the primary operation a, External surface. b, Mesial surface Note the tumor tissue filling the lumina of the divided veins

28, 1923, through a low collar incision The right lobe of the thyroid was found to contain two adenomas one of which was very large and was thought to be carcinomatous For this reason the entire right lobe was removed The left lobe was not disturbed

Macroscopical examination The weight of the small tumor from the region of the lower pole or isthmus was 42 grams, and it measured 5.5 by 4 centimeters It proved to be a benign encapsulated adenoma The weight of the large tumor was 345 grams and it measured 12 by 9 by 7.5 centimeters It consisted of a large encapsulated adenoma partially covered by a thin layer of compressed thyroid tissue The superior, inferior, and thyroidea ima veins were extensively plugged with tumor tissue Section through the tumor showed an old adenoma with areas of edema, some recent and old hemorrhage, and small areas of hyalinized scar tissue but no cystic or calcified areas

Microscopical examination¹ Sections taken from various portions of the tumor showed all manner of variations of histologically benign adenomatous tissue and transition of the adenomatous tissue into histologically carcinomatous tissue which invaded the capsule and grew into the branches of the thyroid veins

A pathological diagnosis of carcinoma of the malignant adenomatous type was made

The patient made an uneventful recovery and was discharged from the hospital on the sixth postoperative day Six days later roentgen treatments were given to the right and left thyroid areas, each field receiving approximately one erythema dose

In January 1929, more than 5 years after the primary operation, the patient returned to the

¹A photograph of the gross specimen and numerous photomicrographs illustrating the extremely varied histology of the primary tumor and the tumor thromboes in the thyroidal veins were published in Surg., Gynec. & Obst., 1924, 39 781-792 (Figs 3 to 22, inclusive) hence illustrations pertaining to the primary tumor are omitted from the present article



Fig 6 Case 2. A histologically benign type of recurrent tumor tissue in a branch of the jugular vein.

clinic because of the presence of a small lump on the right side of the neck which had been developing for about 1 year

On examination a small, hard, irregular mass which was somewhat fixed to the deep structures but was not adherent superficially was found in the right side of the neck (Fig. 4). This had caused no symptoms There was no other clinical or roentgenographic evidence of local recurrence or distant metastasis

The second operation was performed January 31, 1929 under nitrous oxide-ether analgesia A transverse incision was made over the tumor and, after dividing the muscles, we found a brownish friable mass just to the right of the larynx It was adherent to the overlying muscles and overlaid the carotid artery The tumor was removed by sharp dissection, the wound was packed open with gauze, and x-ray treatments of one-half erythema dose each were given into the open wound the day of operation and on the following day

Macroscopical examination. The weight of the mass of tissue removed (Fig 5a) was 11 grams, it measured 5 by 3 by 2 centimeters and included a tumor nodule, 3.5 by 2.5 by 2 centimeters Along one border there were several cord-like branching

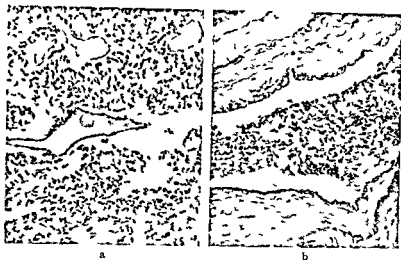


Fig 7 Case 3 a Primary tumor not frankly malignant histologically b Tumor tissue in a vein in the tumor $\times 90$

structures suggestive of a vein wall. Along the opposite border there was a similar cord like structure 6 millimeters in diameter. At one end of this there were clamp marks indicating the site of division. When the sealed edges were opened a large venous trunk was found filled with red, soft friable tissue (Fig 5b).

Microscopical examination. A section through the mass showed a large vein presumably the internal jugular or one of its large branches filled with an adenomatous type of thyroid tissue of variable histological structure closely simulating the histological types noted in the primary tumor removed in 1923. It was not frankly carcinomatous histologically (Fig 6).

The wound was closed on the fifth postoperative day and the patient was discharged on the eighth postoperative day having made an uneventful recovery except for some induration in the wound after secondary closure. Two months after discharge from the hospital a second course of x ray treatment one erythema dose was given over the right thyroid area. The patient was last heard from on February 11, 1936 12 years after the primary operation and 7 years after the removal of the recurrence. He was free of clinical evidence of malignant disease.

In this case the possibility of malignancy was considered before the primary operation but a positive diagnosis was not made. During the primary operation one large adenoma in the right lobe was thought to be malignant hence the entire right lobe was removed. Gross examination of the tissue revealed many large veins around the adenoma filled with

tumor tissue. The histological characteristics of the tissue in the primary tumor and in the plugged veins has been illustrated in a previous publication (see footnote, preceding page).

This patient did not return for more than 5 years after the primary operation, at which time he had an apparently local growth situated at about the site of the upper pole of the right thyroid lobe (Fig 4). It was suspected that the recurrence might be confined to the veins, and the operation for its removal was undertaken with this in view, surgical anesthesia and adequate exposure being used. The subsequent course seems to indicate that this was the only recurrence or metastasis.

The writer is inclined to believe that the recurrence in this case was in the jugular vein or in large venous trunks immediately tributary thereto. The major interest was in completely removing the growth rather than in its precise anatomical location, and rightly so.

CASE 3. A white single female a school teacher 28 years of age registered in the clinic August 27 1928 complaining of goiter of 4 years duration. The family history was negative. The patient had had the usual diseases of childhood. Appendectomy had been performed 5 years previously and tonsillectomy 3 years previously.

The patient first noticed a goiter about 4 years prior to the first examination. It had grown slightly larger in the last 3 months causing a sense of pressure in the neck slight dysphagia and occasional

aching pains in the neck. She had always been nervous but was not increasingly so. There were no cardiac symptoms or loss of weight. She had been taking medicine, presumably some form of iodine, for several months.

On examination none of the cardinal symptoms or signs of hyperthyroidism were noted. There was a firm, discrete, oval nodule 5 by 3 centimeters in the right lobe of the thyroid partially concealed by the clavicle. The remainder of the examination was essentially negative.

A clinical diagnosis of adenoma of the thyroid without hyperthyroidism was made.

One year later the patient returned to the clinic stating that the goiter had increased in size but had caused no particular trouble.

The primary operation was performed September 19, 1929. The right lobe was found to contain two tumor nodules which were thought to be adenomas and a third adenoma was situated in the isthmus. The left lobe appeared to be normal. The right lobe with the two tumors was resected and the adenoma was excised from the isthmus.

Macroscopic examination The weight of the tissue removed was 40 grams. The right lobe measured 8.5 by 4 by 2.5 centimeters. In the lower pole there was an encapsulated tumor mass 2.5 centimeters in diameter which was very hard. The upper portion of the lobe appeared to be non-tumorous. The nodule from the isthmus was a small, encapsulated benign adenoma 1.5 centimeters in diameter.

Microscopic examination A section from the nodule in the lower pole of the right lobe showed a differentiated hyperplastic adenoma with areas of hyalinized scar tissue, old hemorrhage, and areas of calcification. At one end there was an area of rather cellular tissue arranged in solid cords and masses of closely packed epithelial cells not forming acini. The cell masses were separated by a delicate endothelialized vascular network. Mitotic figures were not observed. On account of the histological characteristics of the small area described (Fig. 7a) additional sections were taken which showed similar histological characteristics and the presence of tumor cells in the lumina of some of the capsular veins (Fig. 7b).

On the basis of these findings a pathological diagnosis of hyperplastic goiter with multiple adenomas, one of which was malignant, was made.

The patient made an uneventful recovery and was discharged from the hospital on the seventh postoperative day.

In December, 1933, the patient returned to the clinic because of the appearance of a small nodule in the suprasternal notch which was first discovered in March, 1932, about 2½ years after the primary operation. The nodule gradually increased in size but caused no particular symptoms and did not affect the general health. On examination a firm, elastic mass about the size of a lime was noted and palpable in the suprasternal notch. It was freely

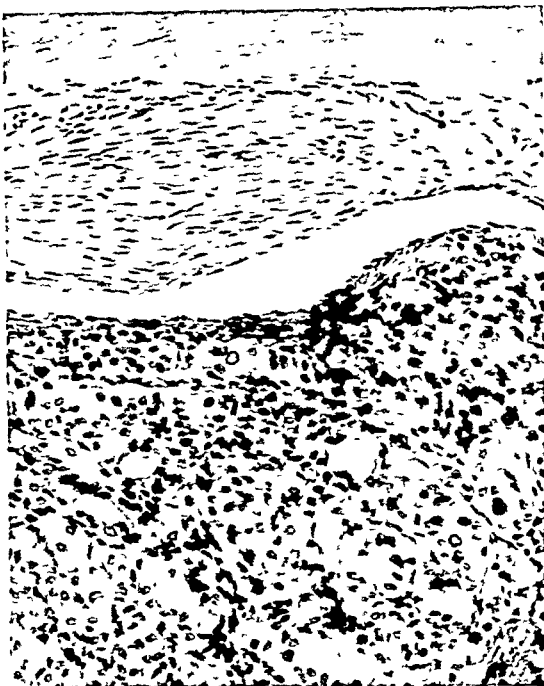
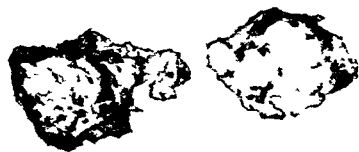


Fig. 8 Case 3 a, above, External and cut surface of the first local recurrence removed more than 4 years after the primary operation. b, The wall of a vein and the histological characteristics of the tumor thrombus in the lumen $\times 135$.

movable under the skin but somewhat more firmly attached to the deeper structures. The mass was interpreted as a probable recurrence and its removal was advised.

The second operation was performed December 27, 1933, under local anesthesia. A transverse incision was made over the nodule and the latter, which was about 3 centimeters in diameter, was removed by sharp dissection. The nodule appeared to have developed in the scar where the pretracheal muscles had been divided at the first operation.

Macroscopic examination The weight of the tissue removed was 12 grams and it measured 3.5 by 3 by 3 centimeters. It consisted of a single, encapsulated nodule (Fig. 8a) of uniform, light yellowish-brown, homogeneous tissue with a small, irreg-

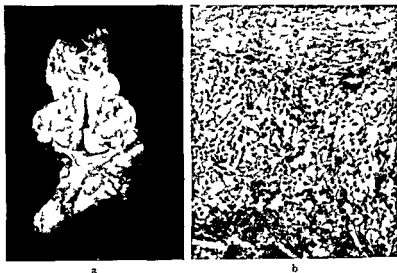


Fig 9 Case 3 a The second local recurrence in the suprasternal region removed 5 years after the primary operation. Note the tumor nodule in the center. At the lower end there is thymic tissue and a parathyroid. b The recurrent tumor nodule $\times 10$.

ular central area of edematous stroma and a more cellular periphery. The nodule was surrounded by fibrous tissue fat and muscle. It was suspected that the nodule was a growth of tumor tissue in a vein but this could not be demonstrated grossly.

Microscopical examination. Sections revealed a large vein filled with adenomatous thyroid tissue consisting of solid nests and cords of rather large cells showing very little tendency to form glands (Fig 8b). The cell masses were separated by a delicate highly vascularized stroma. There was no colloidal material or normal thyroid tissue. A pathological diagnosis of malignant adenomatous thyroid recurrent in the cervical vein was made.

The patient made an uneventful recovery and was discharged from the hospital on the fourth post operative day.

In August 1934, 8 months after excision of the first recurrence, the patient returned to the clinic because of a nodule in the suprasternal notch. This had been present for a few weeks and was increasing in size but caused no symptoms. It was interpreted as a probable recurrence.

The third operation was performed August 19, 1934, under gas anesthesia. A short incision was made in the line of the old scar and a nodule, about the size of an English walnut, was found embedded in the scar in the suprasternal notch and was completely excised, every effort being made to remain outside the capsule.

Macroscopical examination. The weight of the tissue removed was 12 grams and it measured 7 by 2.5 by 2 centimeters. The upper portion consisted of muscle and scar tissue and the lower portion con-

sisted of a mass of firm lobulated tissue somewhat suggestive of thymus. At the junction of the two portions or near the center of the specimen (Fig 9a) there was a small well circumscribed encapsulated nodule 2 centimeters in diameter consisting of light yellowish brown soft friable tissue in which no colloid or normal thyroid tissue could be recognized grossly.

Microscopical examination. Sections of the nodule revealed solid nests of uniform epithelial cells having round oval or irregular vesicular nuclei and considerable finely granular cytoplasm (Fig 9b). The cells showed no tendency to form glands and there was no colloidal material. The cell masses were separated by a delicate network of thin walled capillaries. A section from the lower portion of the specimen disclosed a small lymph node, a normal parathyroid and areas of lobulated thymic tissue with Hassel's corpuscles. A pathological diagnosis of recurrent malignant adenoma was made.

The patient made an uncomplicated recovery and was discharged from the hospital on the fifth post operative day.

The patient was last heard from May 11, 1937, 7½ years after the primary operation, 3½ years after excision of the first recurrence and more than 2½ years after excision of the second recurrence. She was free of clinical evidence of malignant disease and had been teaching school regularly for 2 years.

In this case malignancy was not suspected before or during the primary operation and after the most painstaking gross and micro-

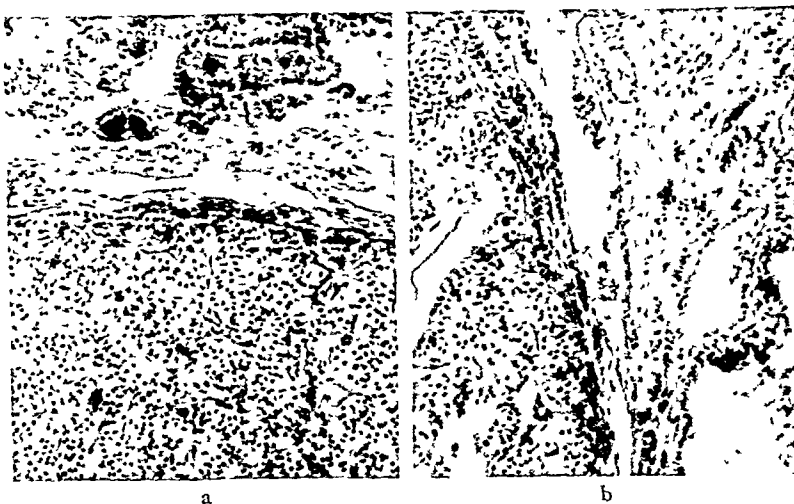


Fig 10 Case 4 a, The primary tumor, histologically benign $\times 95$ b, Tumor cells and clumps of tumor tissue in an endothelial lined venous sinus, the only indication of possible malignancy. $\times 95$

scopical examination of the tissue removed and after making additional sections, it was by no means certain that the tumor was malignant. One of several nodules examined was suspicious on account of the presence of tumor cells in the capsular veins rather than by reason of its histological characteristics.

More than 4 years after the primary operation the patient returned with a small nodule in the suprasternal notch of about 18 months' duration. In view of the previous pathological diagnosis or uncertainty of diagnosis, the nodule was thought to be a recurrence, but it seemed small, superficially situated, and movable. These apparently favorable circumstances led to the decision, which was probably unwise, to remove the growth under local anesthesia. The risk of breaking into the mass or incompletely removing it is great enough at best and should not be further enhanced by inadequate exposure. One should consider not only the obvious mass but also the possible presence of clinically undetectable small masses in the immediate vicinity, and should ligate veins well beyond the mass.

Even though the operation for the removal of the first recurrence seemed to have been accomplished satisfactorily, at least in so far as the obvious nodule was concerned, the patient returned 8 months later with a second

recurrence in the suprasternal notch. At the third operation the patient was given surgical anesthesia, the field of operation was adequately exposed, and the excision was performed well beyond the limits of the growth, through healthy tissue. Three years later the patient was free of clinical evidence of malignant disease. (See note at end of paper.)

CASE 4 An adult white male, 45 years of age, registered in the clinic September 26, 1929, complaining of goiter, nervousness, and fatigue. The family history was negative. The patient had had the usual diseases of childhood and a nervous breakdown in 1917. He first noticed enlargement of the thyroid 3 years previously. The goiter had steadily increased in size since that time and was associated with nervousness, palpitation, tachycardia, fatigue, irritability, and headaches, all of which symptoms were increasing. He worried a great deal about his employment as a mail clerk which he stated was a nerve racking job which almost resulted in a nervous breakdown in June, 1929.

On examination the patient was found to be well nourished, weighing 172 pounds. The pulse rate was 112, blood pressure 134 systolic, 76 diastolic, the skin was warm and moist. There was no exophthalmos or other eye signs. The teeth showed many fillings and crowns. The tonsils were embedded, and there was no general lymphadenopathy. The right lobe of the thyroid was enlarged to about three times the normal size and contained elastic nodules. He had a fine digital tremor; otherwise examination was essentially negative. Clinical diagnosis was adenomatous goiter with hyperthyroidism.

The primary operation was performed October 2 1929 under nitrous oxide-oxygen analgesia and infiltration with novocain. The trachea was found to be displaced to the left. The right thyroid lobe was about four times the normal size and adenomatous in character. The left lobe was about twice the normal size and colloid in character. A subtotal thyroidectomy was performed and the wound was closed around a rubber drain.

Macroscopic examination. The tissue removed consisted of the major portions of the right and left lobes. The weight of these was 190 grams. The right lobe measured 12 by 6.5 by 3.5 centimeters and on section was found to contain a large encapsulated quite cellular finely granular soft tumor in which there were areas of hyaline scar tissue. There was only a small amount of non-tumorous thyroid around the adenoma. The left lobe measured 6 by 2.5 by 3 centimeters and contained one small adenoma 2 centimeters in diameter. Otherwise it consisted of lobulated translucent non-tumorous thyroid rich in colloid.

Microscopic examination. A section from the large tumor in the right lobe showed a partially differentiated adenoma with only a slight amount of colloid. There was considerable edema diffuse hemorrhage and in some areas the tumor was composed of solid cords and masses of cells separated by endothelial lined blood channels (Fig 10a). In these more cellular areas there was no colloid. The cells were of fairly uniform type somewhat variable in size but mitotic figures were not recognized. A few of the endothelial lined blood spaces contained islands of tumor tissue (Fig 10b). In view of this fact additional sections were taken. These showed larger areas of the more cellular type of adenomatous growth arranged in strands and solid masses of cells which were separated by a delicate vascularized stroma. The histological picture was very suggestive but not conclusive for malignancy. A tentative pathological diagnosis of malignant adenoma was made.

The patient made an uneventful recovery and was discharged from the hospital on the seventh postoperative day.

In September 1931 nearly 2 years after the primary operation he returned to the clinic because of a painless swelling in the right side of the neck which had been present for 3 months and was gradually increasing in size.

On examination the thyroidectomy scar was found to be in good condition and there was very little palpable thyroid tissue in front of the trachea. About midway between the episternal notch and the angle of the jaw on the right side of the neck there was a rounded non-tender freely movable mass about 1 3/4 by 3/4 inches in size. No other masses were palpable and there was no other evidence of recurrence or metastasis. The mass was interpreted as a probable recurrence and operation was advised.

The second operation was performed September 12 1931 under local anesthesia only. The tumor

nodule was exposed through a transverse incision and was removed by sharp dissection. The wound was closed.

Macroscopic examination. The tissue removed consisted of two small pieces. Their weight was 4 grams and they measured 2 by 1 by 0.5 centimeters and 1.5 by 1 by 1 centimeters respectively. They appeared to be composed of reddish grey, encapsulated colloid containing thyroid tissue.

Microscopic examination. Sections revealed actively growing hyperplastic adenomatous thyroid tissue consisting of large and small alveoli filled with closely packed epithelial cells of uniform size which were separated by well vascularized stroma and tended to form small acini which contained droplets of colloidal material. There was no normal thyroid tissue present. A pathological diagnosis of recurrent malignant adenoma was made.

The patient made an uneventful recovery and was discharged on the second postoperative day. A few days later approximately one erythema dose of roentgen irradiation was given over the right and left thyroid areas.

In September 1932 the patient came into the clinic for observation. There was no evidence of recurrence.

In April 1933 about 1 1/2 years after excision of the first recurrence the patient returned to the clinic because of the presence of two small nodules in the suprasternal notch which were discovered 2 months previously. These were firm and freely movable and were thought to be recurrences.

The third operation was performed April 26 1933 under full avertin anesthesia only. The previous collar scar was excised the trachea was exposed and the muscles on the right side of the neck were divided transversely for the exposure of the mass which occupied a position corresponding to the right thyroid lobe and extended to the carotid sheath but did not involve the carotid artery or internal jugular vein. The tumor appeared to be encapsulated. During the course of its removal the capsule of the tumor was ruptured and considerable soft tumor tissue was spilled into the neck. The tumor was found to be adherent to the thyroid cartilage but was thought to have been completely removed.

Macroscopic examination. Two pieces of tissue were received for examination. The weight of one which was removed from the upper right thyroid area was 2 grams; it measured 3.5 by 2 by 0.7 centimeters and consisted of fibrofatty and finely lobulated normal appearing thyroid tissue. The weight of the second piece of tissue removed from the lower right thyroid area was 17 grams and it measured 5.5 by 4 by 2.5 centimeters. It consisted of muscle scar tissue and two fairly well circumscribed nodules of firm friable tumor tissue, the capsule of one of the nodules having been ruptured.

Microscopic examination. Sections of the tissue from the upper thyroid area revealed no evidence of malignancy. Sections of tissue from the lower

thyroid area revealed actively growing adenomatous thyroid composed of solid strands and masses which were separated by highly vascularized stroma. The cell masses tended to form small and fairly large acini some of which contained droplets of colloid and an occasional mitotic figure was seen. Small blood vessels around the capsule contained clumps of tumor tissue. In general the tumor nodules appeared to be well circumscribed or encapsulated, and there was very little tendency to invade beyond the capsule.

A pathological diagnosis of recurrent malignant adenoma was made.

Following this operation there was hoarseness, a right abductor paralysis, and some induration but no discharge of serum from the wound. Otherwise the recovery was uneventful and the patient was discharged from the hospital on the tenth postoperative day.

In September, 1933, the patient was in the clinic with no evidence of recurrence, and he had regained his voice.

In March, 1934, he returned to the clinic having discovered two small nodules just above the scar on the right side of the neck, each about 1 centimeter in diameter.

The fourth operation was performed March 6, 1934, under analgesia and infiltration with novocain. One nodule was found embedded in the sternohyoid muscle and was removed. Immediately beneath the muscle there was a second, more deeply seated nodule in the space between the larynx and the carotid sheath. This nodule was attached to the laryngeal cartilage, a part of which was removed along with the tumor mass.

Macroscopical examination. The tissue received for examination consisted of a piece of muscle from the right side of the neck including a small well encapsulated mass of tumor tissue measuring 1 by 1 by 0.7 centimeter and a piece of tissue including a tumor nodule removed from the thyroid cartilage measuring 3 by 2.5 by 1.5 centimeters in which there was a circumscribed tumor nodule 1.3 centimeters in diameter, and several small fragments of muscle and scar tissue from the right thyroid area which were not grossly involved by tumor.

Microscopical examination. Sections of the various nodules showed actively growing adenomatous thyroid tissue similar in general characteristics to the recurrent nodules removed on previous occasions. It was not frankly carcinomatous histologically. Masses of tumor cells were present in venous channels.

A pathological diagnosis of recurrent malignant adenoma was made.

The patient made an uneventful recovery except for partial separation of the wound edges which were secondarily closed with clips. He was discharged from the hospital on the seventh postoperative day. There was continuance of the right abductor paralysis.

May 8, 1935 the patient was readmitted to the

hospital for removal of several small nodules in the incision and one at the level of the larynx. These were freely movable and had been present a few weeks.

The fifth operation was performed May 8, 1935, under nitrous oxide-oxygen anesthesia. One small, hard, fixed nodule was removed from the region of the thyroid isthmus. A second nodule was removed from the digastric triangle and a third nodule situated in the lower right cervical region was found to be quite extensive and infiltrating into the carotid sheath and a portion extended behind the sternum. As much as possible of this nodule was removed. On account of oozing, the neck was packed open and closed the following day. The three pieces of tissue received for examination proved to be recurrent adenomatous tumor tissue similar to that observed on previous occasions. The recovery was uneventful and the patient was discharged on the seventh postoperative day.

Following discharge from the hospital the patient was given roentgen irradiation, approximately one erythema dose over each lateral thyroid area.

In December, 1935, another similar course of roentgen irradiation was given over the right and left thyroid areas. The patient had been seen on several occasions and there was no evidence of recurrence.

In April, 1936, the patient came into the clinic with no evidence of recurrence.

The patient was last seen at the clinic October 8, 1936, 7 years after the primary operation and about 1½ years after excision of the fourth recurrence. His general condition was good, but there was one small shot-like nodule at the outer end of the incision.

This case further emphasizes what we believe to be a prime fallacy in the treatment of recurrences of this type. When the patient returned about 2 years after the primary operation, with a mass in the right side of his neck, various observers all agreed that it was rounded, appeared to be encapsulated, and was movable. Perhaps on account of the uncertainty of the original pathological diagnosis and the possibility that the mass might be a lymph node rather than a recurrence, its removal was attempted under local anesthesia. During the course of the operation the mass was ruptured but was thought to have been completely removed. One year later the patient was apparently free of recurrence but when seen 6 months afterward there were two small nodules in the suprasternal notch. The second and subsequent operations for removal of recurrences were more extensive and were conducted under full anesthesia, but the

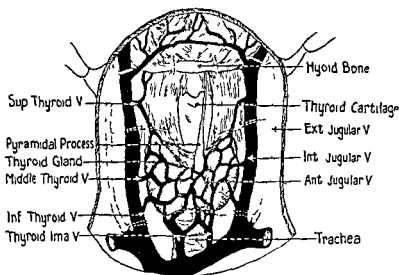


Fig 11 A diagrammatic representation of the bilateral intercommunications between the thyroid plexus of veins and the external and internal jugular veins in the neck. A tumor which involves a lateral lobe of the thyroid might extend via one or more of the venous routes and might produce local growths in the distribution of the superior middle inferior or thyroidea ima veins

tumor became more widely disseminated and progressed beyond the possibility of complete surgical removal. When last seen, the patient still had recurrence and a cure is not to be expected. The duration of life, however, is difficult to predict. (See note at end of paper.)

EVALUATION OF STUDY

This paper is a preliminary report of our experiences with a selected group of thyroid neoplasms in which the primary operation for their removal has been followed by the development of local recurrences in the veins of the neck, without detectable evidence of distant metastases.

The primary operations upon the patients whose histories are submitted were performed before the appearance of the article entitled "Radical Operation for Malignant Tumors of the Thyroid Gland," recently published by Dr. George Crile and Dr. George Crile, Jr.¹ and which was designed, in part at least, to prevent or decrease the incidence of just such local recurrences as are illustrated by the cases here reported.

Local recurrences of this nature are probably more prevalent than one would suspect from a perusal of current literature. The writer is unaware of any publications dealing with this particular phase of malignant goiter.

An appreciation of the manifold opportunity for such local recurrences and their possible distribution may be gained from a study of the bilateral intercommunications between the venous networks of the lateral thyroid lobes and the internal, external, and anterior jugular systems and their convergence toward the innominate veins and the vena cava (Fig 11).

Naturally, anything in the way of a diffuse permeation of this venous maze would almost certainly preclude the possibility of successful surgical removal, and such cases do not come within the scope of the present discussion. We are concerned here with recurrent nodules of limited number and limited distribution, which on clinical examination, are found to be accessible and to have a degree of mobility such as to justify the expectation that they can be removed.

It is to be specifically understood that reckless and futile block dissections of the neck

¹Crile, George S. and Crile, George Jr. "Radical operation for malignant tumors of the thyroid gland." *Surg. Gynec. & Obst.* 1937 64 927-934.

obviously hopeless cases are not advocated. It is emphasized, however, that in certain instances the circumstances are favorable and for these we are asking special consideration.

The circumstances which, with few exceptions, are common to the cases here reported and which may be indicative of a possibly favorable outcome may be briefly summarized as follows:

Clinical findings. All the patients had adenomatous goiter. All were free of symptoms and signs of hyperthyroidism except Case 4, in which the syndrome was fairly definite. In no instance was a positive clinical diagnosis of malignancy made before the primary operation; such a condition was discussed as a possibility in Case 2. During the course of the primary operation, malignancy was not suspected in 3 cases, but was suspected in Case 2 in which the same question had been raised clinically.

Pathological findings at the primary operation. In all cases the thyroid tissue removed contained adenomas which appeared to be encapsulated; invasion of the capsule and gross plugging of the veins by tumor tissue were absent, except in Case 2. In none of the cases was the tumor as a whole frankly carcinomatous from a purely histological standpoint; in Case 2, however, there were areas which could be interpreted as histological cancer. The pathological diagnosis in Case 1 was multiple fetal adenomas; in Case 2, malignant adenoma; Case 3, hyperplastic goiter with multiple adenomas, one of which was malignant; Case 4, a tentative diagnosis of malignant adenoma was made. None of the tumors was cystic or distinctly papillary in character.¹ The pathologist as well as the clinician at the time of the primary operation had difficulty in making a positive diagnosis of malignancy. The one constant sign which might have suggested the possibility of future trouble was the presence of tumor cells or tumor tissue in the lumina of the capsular veins, and this sign was positive in the 4 cases reported. In these cases we were dealing with a previously benign adenoma which tended to become malignant and in which the histologically adenomatous char-

acteristics predominated over the carcinomatous. The intensity of the malignancy was of a low order.

Postoperative course. A striking feature of the postoperative course of the tumors under consideration is the relatively long latent period before the appearance of the local recurrences and their tendency to remain localized. This is consistent with the relatively low order of the malignancy of the primary tumors and the recurrences and is in striking contrast to the rapidity of recurrence and dissemination in the highly malignant undifferentiated or diffuse carcinoma of the thyroid. Hence, in the case of tumors of low grade malignancy in which tumor cells or tumor tissue are demonstrated in the veins at the time of the primary operation for adenomatous goiter, one would be justified in suspecting regrowth of the tumor in the veins in any patient returning 2, 3, or several years later with a localized, apparently encapsulated mass in the thyroid area. If, under such circumstances, there is no clinical evidence of distant metastases and if the mass is freely movable or has only limited fixation as has been the case in the instances here recorded, operative treatment is indicated.

Surgical treatment of local recurrence. The operation might be of an exploratory nature if deemed advisable but the operative procedure should be carried out in such a manner as not to lose the opportunity of completely removing the mass if it be removable, and with little or no curiosity about what is inside of it. Breaking into the mass, leaving remnants of it in the operative wound, and failure to remove tributary veins in which tumor tissue is present are almost certain to render a second successful surgical attack impossible. For these reasons it is probably inadvisable to attempt to remove these apparently innocuous, freely movable recurrent nodules under local anesthesia, especially if they are deeply situated in the neck. The more prudent course would seem to be to employ surgical anesthesia, to expose adequately the tissue to be removed, and to pay particular attention to the condition of the venous tributaries around the mass.

The peculiar nature of the pathological process involved should be well understood

¹Tumors of the thyroglossal tract and tumors of lateral aberrant thyroid origin do not come within the scope of this discussion.

before institution of the *first surgical procedure for the removal of the recurrence* in order that the surgical attack may be directed against the vascular apparatus which harbors the growth, and that the details of the operation may be designed to accomplish its purpose, namely, complete removal of the lesion. Biopsies, inadequately conceived, and illy executed surgical procedures are not in the best interests of the patients now under consideration. *The first operation for the removal of the recurrence offers the best and, perhaps, the only opportunity for a cure.*

Irradiation. Radium and roentgen therapy, at least within the limitations of the irradiation dosage employed in the cases reported, was ineffectual in preventing recurrences or curing recurrences. In Case 1, radium treatment was given over the right thyroid area immediately following the operation for removal of the recurrence in the right lobe. Seven months later 2 radium treatments were given over the recurrence in the left jugular vein. The mass persisted for the succeeding 8 years, at the end of which time it was removed surgically, and no irradiation was employed after this third operation. More than 6 years later the patient was free of recurrence. In Case 2, Coolidge tube treatment was given over the right and left thyroid areas shortly after the primary operation. Recurrence in the right cervical veins appeared 4 years later and was removed about $1\frac{1}{2}$ years

afterward. Following removal of the recurrence, roentgen irradiation was given into the open wound and 2 months later a second course was given. More than 7 years after this last treatment the patient was free of recurrence. In Case 3 no irradiation was employed. In Case 4 roentgen irradiation was given over the right and left thyroid areas shortly after removal of the first recurrence. Within the next $3\frac{1}{4}$ years recurrences were excised on 3 occasions, following the last of which roentgen irradiation was given and repeated 7 months later. When last seen the patient had a recurrent nodule in the scar.

The most effective treatment of local recurrences of the type reported has been surgical removal, and there would seem to be no reason for withholding it in favorable cases of this apparently radioresistant type of growth.

NOTE.—Since the completion of this paper 2 of the patients have returned to the clinic for removal of recurrent nodules in the neck. In Case 3 there were two small nodules, one of which was situated in the dermis near the right external end of the thyroidectomy wound and the other was situated in the suprasternal notch mesial to the right sternomastoid. These two nodules were removed under general anesthesia July 27, 1937 and proved to be similar histologically to the previously removed recurrent nodules. In Case 4 there was a small nodule immediately beneath the skin near the right end of the old operative wound and a second larger deeply situated mass near the trachea on the right side which apparently extended posterior to the right sternoclavicular joint but there was no evidence of distant metastases. The small superficial nodule was excised under nitrous oxide and novocain anesthesia on June 29, 1937 and proved to be similar histologically to the recurrent nodules removed on previous occasions.

STUDIES ON THE CIRCULATION IN PREGNANCY

II. Vital Capacity Observations in Normal Pregnant Women

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EVEN though numerous reports concerning the vital capacity (by definition, the maximum amount of air that can be exhaled after the deepest possible inspiration) in pregnancy have appeared in the literature (Table I) since the introduction of spirometry into clinical medicine by Jonathan Hutchinson in 1846, there is no conclusive evidence as to what influence normal pregnancy has on vital capacity. A review of the literature (3, 4, 7, 14, 16, 17, 23, 29, 30, 35, 36, 40, 41, 42) and most of the modern American text books on obstetrics (6, 11, 12, 13, 37) gives vague and conflicting information concerning the vital capacity in normal pregnancy and little information concerning the vital capacity in pregnant cardiac women, in the pregnancy "toxemias" and other abnormal obstetrical conditions.

For the evaluation of certain physiological phenomena that occur in normal pregnancy such as dyspnea and orthopnea, knowledge of the effect of pregnancy on the vital capacity is important. Also, in a search for an early sign of heart failure in pregnant cardiac patients, one naturally turns to tests of clinical value in the non-pregnant. Of these, the vital capacity determination is the simplest and probably most valuable. In order to evaluate such observations in abnormal situations in pregnancy, an accurate knowledge of what happens in the normal pregnant woman is necessary.

For this reason, vital capacity determinations were made in conjunction with other circulatory studies as a part of a general study on the circulation in pregnancy. The complete data of the circulatory studies on 19 of

the subjects under study were presented in a previous report (10).

This report presents observations on the vital capacity in a group of 31 normal pregnant women.

PROCEDURE

The subjects for this study were obtained from the prenatal clinic of The Boston Lying-in Hospital. Those included presented no evidence of serious medical or obstetrical disorder. Individual patients were excluded from the group only when, through lack of co-operation or inability to perform the tests, satisfactory observations could not be made.

In addition, a small control group of 9 normal non-pregnant women in the same age group was observed over a 14 month period, usually at monthly intervals.

Of the pregnant group, vital capacity observations were usually made at monthly intervals before delivery, at 2 and 6 weeks postpartum and in some instances as long as a year or more after delivery.

All determinations were made after at least 12 hours of fasting. Early in the study observations were made with patients in the lying, sitting, and standing positions. Determinations taken with patient in the sitting position were especially adaptable to study of all pregnant women, since observations could be made on postpartum and sick subjects under practically the same conditions as on ambulatory patients, the only difference being that the ambulatory and convalescent patients were allowed to dangle their legs over edge of bed while the others were required to sit erect in bed. For reasons discussed later, it soon appeared that the lying and standing determinations added nothing to make their continuance an important part of the study.

The subjects were required to sit quietly at least 30 minutes before readings were initiated

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The complete data on which this report is based will appear in tabular form in the reprints

and a 5 minute rest interval was required between determinations. When the lying and standing observations were made, a 30 minute rest period was required in each position before the test was started, and readings were then made in the manner described.

Each subject was given a demonstration of precisely how the test was performed and its proper execution was demanded on each attempt. The patient was instructed to exhale slowly first, then to make a maximum rapid inspiration after which the mouthpiece of the spirometer was inserted in the mouth promptly and without loss of air to the exterior, then to exhale forcibly into the spirometer and to continue expiration until the lungs were emptied as completely as possible. At each attempt the subject was urged to make a maximum effort. At the first visit several trials were often necessary before the patient could perform the test properly. If vital capacity determinations are made under these conditions and in the manner described, its constancy on any day is remarkable. A series of at least 3 determinations which checked within 50 cubic centimeters of each other and were satisfactory attempts (patient cooperative, maximum inspiration complete expiration, no extra breaths, no leakage) was considered a test and the highest reading of the group was taken as the vital capacity for that day.

The importance of adhering to the conditions under which the test is carried out and the exact method of actually performing the test can not be overemphasized. If these conditions are followed rigorously, the variations observed in the vital capacity from month to month are likely to be due to actual changes in the vital capacity and not to variations in technique.

As a means of comparing the vital capacities of different non pregnant individuals, it has been shown by West and by Christie and Beams that correction for body surface area is the most accurate. Accordingly such correction was made in this study. The surface area was calculated from the height weight tables based on the formula of DuBois and DuBois. Since no accurate method of determining the surface area of pregnant women is available, it was calculated on the basis of the

patient's "normal" non pregnant weight and height.

For normal non pregnant women the vital capacity is, according to Christie and Beams, approximately 2000 cubic centimeters per square meter body surface area. They showed that although it may normally rise above this figure, a decrease of 15 per cent or more is usually considered as abnormal. These figures have been used as a basis for comparison between non pregnant women and pregnant women.

In addition, correction was also attempted for "corrected" surface area, this being computed from the patient's height and actual weight (15) as observed at varying times during pregnancy and the puerperium.

METHODS

The vital capacity was measured with a plain water spirometer (Collins). The subcostal angle was measured with a protractor, the 3 determining points being the xyphoid process and points 7 centimeters from it on the border of each costal margin.

Seven foot x ray photographs of the heart and lungs were taken on some of the patients and in a few at monthly intervals throughout pregnancy and at the various observation periods in the puerperium.

Either subjective or objective evidence of shortness of breath was interpreted as dyspnea.

The duration of pregnancy in weeks which represents the time during pregnancy at which any observation was made has been calculated from the actual date of delivery. The duration of a normal full term pregnancy being taken as 40 weeks.

RESULTS

Vital capacity and related observations on 31 normal pregnant women (21 primiparae, 10 multiparae) comprise the material for this report.¹ All the patients in this series were observed at least once antepartum and at least once postpartum. Unless otherwise specified, the vital capacity determinations

¹In addition to 34 observations on 1 to 4 observations per case were made on 59 additional normal pregnant women since no postpartum observations were made on these data are not included. The antepartum course was however similar to that of the cases reported in this paper.

presented will be those which were measured with the patients in the sitting position.

COMPARISON OF VITAL CAPACITIES TAKEN IN LYING (SUPINE), SITTING, AND STANDING POSITIONS

In 10 cases vital capacity determinations were made on the same date with the patients in the lying, sitting, and standing positions. In general the changes during pregnancy and the puerperium were similar regardless of the position of the patient in which determinations were made (Fig 1). The vital capacity was usually higher when taken with the patient standing than in the other positions and higher sitting than lying. This is similar to the studies on the non-pregnant cases of Hasselbalch (22) and of Christie and Beams. There is a rather small difference between the sitting and standing determinations while the lying determinations are about 5 per cent less than either the sitting or standing vital capacities. Because of the similarity in the trend of vital capacity change in pregnancy and the puerperium and because of the similar value of the sitting and standing observations, the sitting position was chosen because of its applicability to this study as well as that of patients unable to stand, particularly decompensated cardiacs.¹

Regardless of which of the above positions was used in taking observations, it is evident that the vital capacity either remains the same or rises slightly in most of the cases as

¹Studies on the vital capacity in pregnant cardiac patients will appear in a subsequent paper

TABLE I.—VITAL CAPACITY IN NORMAL PREGNANT WOMEN—SUMMARY OF THE LITERATURE

Observer	Year	Number of cases	Vital capacity			Number of cases with post-partum observations
			Increase	Decrease	No change	
Kuchenmeister (29)	1849	5	Yes	-		3
Fabius (17)	1853	?	Yes			?
Wintrich (40)	1854	52			Yes	12
Dohrn (14)	1866	100	26 cases	60 cases	14 cases	100
Zhurakovski (42)	1893	30	3 cases	20 cases	7 cases	30
Hasselbalch (23)	1912	1	Yes			1
Wittich, Meyers and Jennings (41)	1920	?			Yes	?
Root and Root (35)	1923	1	Yes		..	1
Bell (7)	1924	?			Yes	?
Rowe, Alcott and Mortimer (36)	1925	26	Yes	-		0
Alward (3)	1930	60		Yes		60
Anthony and Hansen (4)	1933	27	18 cases	5 cases	4 cases	27
Eunight, Cole and Hitchcock (16)	1935	7	Yes			7
Landt and Benjamin (30)	1936	19			Yes	19

pregnancy progresses and falls after delivery; remaining at a lower level postpartum than antepartum.

OBSERVED VITAL CAPACITY (SITTING)

One hundred sixty-nine vital capacity observations were made on 31 normal pregnant

TABLE II—AVERAGE VALUES

	Weeks pregnant							Weeks postpartum		
	13-16	17-20	21-24	25-28	29-32	33-36	37-40	1-2	3-6	7+
Observed vital capacity in c cm	3264	3224	3300	3314	3346	3385	3455	3704	3153	3248
Vital capacity in c cm per square meter body surface area	2103	2112	2116	2156	2168	2179	2205	2267	2250	2112
Vital capacity in c cm per square meter body surface area "corrected"	2064	2135	2023	1989	2039	2055	2004	2007	1979	2000
Body weight in pounds	122.7	119.6	130.0	127.8	137.2	138.1	145.5	123.9	120.5	117.4
Surface area in square meters	1.58	1.57	1.62	1.60	1.66	1.67	1.73	1.59	1.57	1.55
Subcostal angle in degrees	63.5	60.3	80.0	83.5	83.7	93.1	103.5	74.8	62	65

The average observed vital capacity, vital capacity per square meter body surface area, vital capacity per square meter body surface area "corrected" and the average weight, body surface area and subcostal angle for the various periods of observation during pregnancy and the puerperium in 31 normal pregnant women.

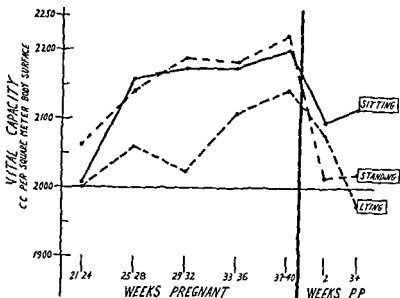


Fig 1 The average vital capacity lying sitting, standing in cubic centimeters per square meter body surface area (uncorrected) in 10 normal pregnant women. The horizontal line represents the average normal vital capacity for non pregnant women. The heavy perpendicular line represents delivery and separates the antepartum and postpartum periods. Note that the lying vital capacity is about 5 per cent less than sitting and standing the general trend in all positions is however the same.

women (117 antepartum, 52 postpartum), the number of antepartum observations varied between 1 and 6, the postpartum observations varied between 1 and 3. Four patients were observed once antepartum 5 twice 2 three times, 10 four times, 3 five times, and 7 six times. These antepartum observations were distributed as follows during the 9 to 12 week period, 2 cases, during the 13 to 16 week period, 10 cases, during the 17 to 20 week period, 11 cases, during the 21 to 24 week period, 17 cases, during the 25 to 28 week period, 19 cases, during the 29 to 32 week period, 20 cases, during the 33 to 36 week period 20 cases, during the 37 to 40 week period, 18 cases.

Fifteen cases had 1 postpartum observation, 11 had 2 postpartum observations, 5 had 3 postpartum observations. The postpartum observations were made during the 1 to 2 week period in 27 cases, in the 3 to 6 week period in 10 cases, and in the 7 weeks or later period in 15 cases.

For the most part, the values were within the normal range for non pregnant women.

The smallest observed vital capacity value antepartum was 2,150 cubic centimeters, the largest 4,100 cubic centimeters. Postpartum the range was from a minimum of 2,510 cubic centimeters to a maximum of 4,050 cubic centimeters. The average of all antepartum observed vital capacity observations was 3,346 cubic centimeters, the postpartum average of all the observed values was 3,284 cubic centimeters.

Although not present in every case or at every observation there was a tendency for the vital capacity to increase during pregnancy and decrease after delivery. In 22 of 31 cases the last antepartum vital capacity was higher than the first in 4 it was less, in 1 there was no change and in 4 there was only one antepartum observation so that such a comparison was impossible. Further, in 24 of the 31 cases the highest antepartum vital capacity was higher than the highest postpartum observation, in 6 the reverse was true. In only 1 case was there evidence of neither antepartum increase nor postpartum decrease. The average of the vital capacities of

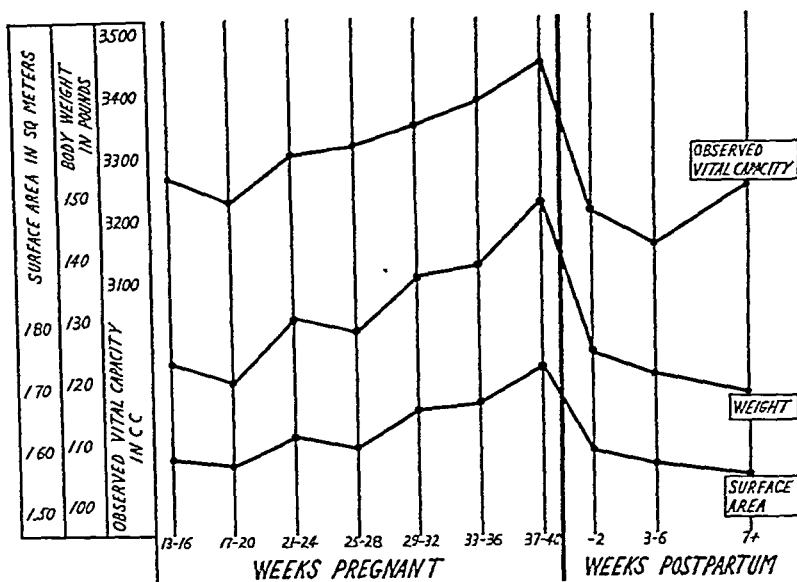


Fig 2 The average observed vital capacity, weight, and surface area (based on weight change in pregnancy) in normal pregnant women. The heavy perpendicular line represents delivery and separates the antepartum and postpartum periods

the entire group showed a progressive increase from the twenty-first to twenty-fourth week value of 3,300 cubic centimeters throughout the remainder of the pregnancy, reaching its highest value of 3,455 cubic centimeters in the thirty-seventh to fortieth week period (Fig. 2)

The average observed antepartum vital capacity values were as follows. for the 13 to 16 week period, 3,264 cubic centimeters; for the 17 to 20 week period, 3,224 cubic centimeters; for the 21 to 24 week period, 3,300 cubic centimeters; for the 25 to 28 week period, 3,314 cubic centimeters; for the 29 to 32 week period, 3,346 cubic centimeters; for the 33 to 36 week period, 3,385 cubic centimeters, for the 37 to 40 week period, 3,455 cubic centimeters. The average postpartum values were: for the 1 to 2 week period, 3,204 cubic centimeters, for the 3 to 6 week period, 3,153 cubic centimeters, for the 7 plus week period 3,248 cubic centimeters

After delivery there was a sharp drop in the average vital capacity from the thirty-seventh to fortieth week value of 3,455 cubic centimeters to 3,204 cubic centimeters in the first to second week postpartum period. It

remained at essentially the same level throughout the postpartum observation period which in some patients extended over a year period (6 cases) or longer (the longest postpartum observation being 81 weeks)

It can be seen from both individual cases and the average values that the observed vital capacity increases slightly or remains constant as pregnancy progresses, decreases abruptly following delivery (2 weeks postpartum) to its lowest level in the study, and then returns to a level similar to that observed in early pregnancy. This is presumably equal to the "normal" non-pregnant level, although there are no data on that point.

The maximum increase in the prepartum vital capacity with the first observation taken as 100 per cent amounted to approximately 12 per cent (Case 31).

The maximum decrease in the vital capacity observed during the course of pregnancy with the first observation taken as 100 per cent amounted to approximately 7 per cent (Case 40).

For purposes of comparison the changes in body weight and approximate surface area

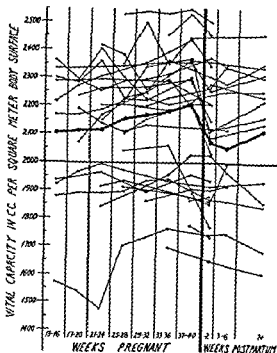


Fig 3 The vital capacity in cubic centimeters per square meter body surface area (uncorrected) in normal pregnant women. The horizontal line represents the average normal vital capacity for non pregnant women. The curves of individual cases are plotted separately the curve of average values being plotted with a heavier line. The heavy perpendicular line represents delivery and separates the antepartum and postpartum periods.

computed from the changes in weight are charted with the observed vital capacity (Fig 2)

VITAL CAPACITY, CORRECTED

A On basis of "normal surface area. In order to compare the vital capacities of different pregnant individuals with each other and with non pregnant women, the vital capacity per square meter body surface was calculated from the observed vital capacity and the surface area of the patient. For reasons pointed out previously, the surface area was that determined from the patients measured height and the "normal" non pregnant weight i.e. the "normal" non pregnant surface area.

Each value for observed vital capacity during pregnancy and the puerperium was divided by this "normal" surface area value

with the resulting value being termed vital capacity in cubic centimeters per square meter body surface area.

On this basis the average values antepartum were for the 13 to 16 week period, 2,103 cubic centimeters, for the 17 to 20 week period 2,112 cubic centimeters, for the 21 to 24 week period, 2,116 cubic centimeters, for the 25 to 28 week period, 2,156 cubic centimeters, for the 29 to 32 week period, 2,168 cubic centimeters, for the 33 to 36 week period, 2,179 cubic centimeters for the 37 to 40 week period 2,203 cubic centimeters. The postpartum averages were for the 1 to 2 week period, 2,067 cubic centimeters, for the 3 to 6 week period, 2,030 cubic centimeters for the 7 plus week period 2,112 cubic centimeters. The minimum value antepartum was 1,470 cubic centimeters the maximum value was 2,555 cubic centimeters the average of all the antepartum observations was 2,158 cubic centimeters. The postpartum minimum value was 1,605 cubic centimeters, the maximum was 2,500 cubic centimeters, the average of all the postpartum observations was 2,077 cubic centimeters.

Since for each patient the correction factor remains constant the changes observed in the vital capacity during the course of pregnancy and the puerperium for the individual cases will be similar to those noted under the observed vital capacity.

The curve of average values differs but slightly from the average curve of the observed vital capacity (Fig 3).

On the basis of comparing the last antepartum observation with the first, 22 cases showed an increase in vital capacity as pregnancy progressed, 4, a decrease, 1 no change, and in 4 single observations antepartum prevented such a comparison. Twenty four of the 31 cases showed the highest antepartum observation to be higher than the highest postpartum observation while 6 showed the opposite and 1 showed no change.

The values of the vital capacity in most instances approximated the value set as normal for non pregnant women i.e. 2,000 cubic centimeters per square meter body surface area (8). Nineteen had vital capacity above 100 per cent of normal, 21 of the 31 had vital capacity of at least 90 per cent of normal, 29

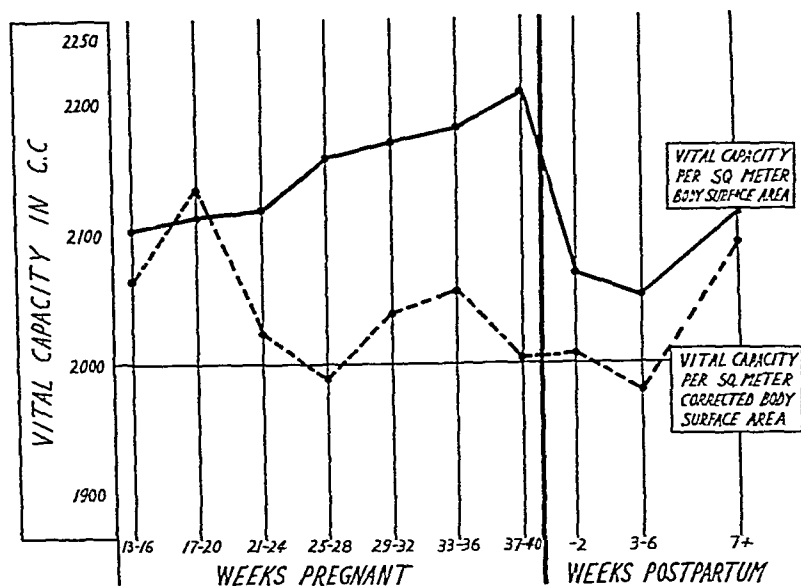


Fig. 4 The average vital capacity in cubic centimeters per square meter body surface area (uncorrected) and corrected for weight change in pregnancy. The horizontal line represents the average normal vital capacity for non-pregnant women. The heavy perpendicular line represents delivery and separates the antepartum and postpartum periods.

had vital capacity of at least 85 per cent of normal; only 1 of the entire group (Case 31) falling below 80 per cent. In this patient the vital capacity was 74 per cent of normal at its lowest level in the twenty-fourth week of pregnancy and 88 per cent of normal at its highest level in the thirty-sixth week of pregnancy. The postpartum vital capacity observations on this patient made at 2, 6, 26, and 65 weeks after delivery never exceeded the highest pregnancy value of 88 per cent of normal.

B. On basis of surface area corrected for weight changes during pregnancy. An attempt was made to adjust the vital capacity for surface area changes during pregnancy. Since no accurate method was known for determining the surface area during pregnancy, the usual height-weight tables (15) calibrated really for non-pregnant individuals, was used which probably approximates the actual surface area in pregnancy. It seemed of interest to carry out this calculation, inexact as it is, to get some idea of how the vital capacity was changing with respect to the changes in surface area that occur as pregnancy progresses.

When this was done it was found that the adjusted vital capacity decreased between the 17 to 20 and the 25 to 29 week periods, increased to a maximum at the 33 to 36 week period, decreased at the 37 to 40 week period, remained constant at the 2 week postpartum period then increased again (Fig. 4). It will be seen from this that the vital capacity did not increase proportionate to the surface area increase, hence there was, in the adjusted vital capacity, a decrease. For instance, the observed vital capacity increased in the 37 to 40 week period, but since the weight and the adjusted surface area, which reflects this change, increased proportionately more, there is an apparent decrease in the vital capacity when corrected for this factor.

The average values of the vital capacity "corrected" for surface area changes in pregnancy were: for the 13 to 16 week period, 2,064 cubic centimeters; for the 17 to 20 week period, 2,135 cubic centimeters; for the 21 to 24 week period, 2,023 cubic centimeters; for the 25 to 28 week period, 1,989 cubic centimeters, for the 29 to 32 week period, 2,039 cubic centimeters, for the 33 to 36 week

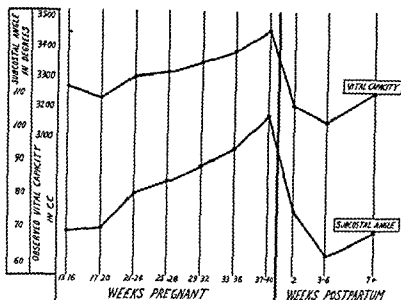


Fig 5 The relationship between the average observed vital capacity and the average curve of subcostal angle values. The heavy perpendicular line represents delivery and separates the antepartum and postpartum periods. Note the close correspondence between the two curves.

period, 2,055 cubic centimeters, for the 37 to 40 week period, 2,004 cubic centimeters. Postpartum the average values were for the 1 to 2 week period, 2,007 cubic centimeters, for the 3 to 6 week period, 1,979 cubic centimeters, for the 7 plus week period, 2,090 cubic centimeters. The minimum value antepartum was 1,396 cubic centimeters, the maximum 2,475 cubic centimeters, the average of all the antepartum observations was 2,043 cubic centimeters. The minimum value postpartum was 1,586 cubic centimeters, the maximum was 2,457 cubic centimeters, the average for all the postpartum values was 2,030 cubic centimeters.

Subcostal angle The subcostal angle was measured 126 times on 25 patients, 86 times antepartum and 40 times postpartum. There is a progressive increase in the subcostal angle as pregnancy progresses, seen in 18 of 25 cases and in the curve of average values (Fig 5), in 4 cases there were single antepartum observations and in 3 of the cases no change was noted. In no instance did the subcostal angle decrease in size during the antepartum period.

By the second week postpartum there is a sharp decrease in the subcostal angle which in the group averaged 28.7 degrees. By the seventh week postpartum or later the subcostal angle had returned to its early pregnancy level (Fig 5).

The average values for the antepartum subcostal angle were for the 13 to 16 week period, 68.5 degrees, for the 21 to 24 week period, 80.0 degrees, for the 25 to 28 week period, 83.5 degrees, for the 29 to 32 week period, 88.7 degrees, for the 33 to 36 week period, 93.1 degrees, for the 37 to 40 week period, 103.5 degrees. Postpartum the average values were, for the 1 to 2 week period, 74.8 degrees, for the 3 to 6 week period, 62.0 degrees, for the 7 plus week period, 68.0 degrees.

X ray studies The lung markings were increased without exception in x ray photographs of the chest taken during pregnancy. Postpartum x ray photographs of the chest resembled those of non pregnant women except for variations interpreted as due to shadows of the enlarged lactating breasts.

The diaphragms were elevated during pregnancy. In 3 cases studied at frequent inter-

vals with x-ray photographs of the chest, the diaphragms maintained their position relative to the ribs, yet the distance from a fixed point (the transverse process of the first thoracic vertebra) to the dome of the diaphragm (the vertical or long diameter of the chest) decreased as pregnancy progressed and increased postpartum. The maximum antepartum decrease was 4 centimeters, the maximum increase postpartum as compared with the minimum antepartum value was 3.5 centimeters. Also, the transverse diameter of the chest increased antepartum and decreased postpartum. The maximum increase in the transverse diameter of the chest during pregnancy was 2.1 centimeters.

As the transverse diameter of the chest increased and the long diameter diminished during pregnancy the vital capacity increased. Postpartum, when the chest configuration returned to normal, changes in the diameters of the chest occurred which were the reverse of those just described and, concomitant with them, the vital capacity diminished.

During fluoroscopic examination of the thorax, the diaphragms, although elevated during quiet respiration, were seen to be capable of moving with apparently normal excursion during forced inspiration and expiration, although at a somewhat higher level than in the non-pregnant state.

Dyspnea. Dyspnea occurred in 18 of the 31 patients, i.e., in approximately 60 per cent. It appeared as early as the third month in 1 patient (Case 45) and in 1 patient continued into the puerperium (Case 31). It was noted in every month of pregnancy. It was noted in the second week postpartum (Case 31). In some patients it was present one month, absent the next, and later recurred; in others it persisted over a several months' period irrespective of how the vital capacity was changing. However, it tended to be present somewhat more frequently in the latter months of pregnancy.

Dyspnea, therefore, bore no constant relationship to vital capacity; in this group it occurred in some cases in which the vital capacity was highest and in others it was found to be absent when the vital capacity was at its lowest.

EVALUATION OF STUDY

Irrespective of the mode of presentation of the data, except on the basis of "corrected" surface area, the vital capacity increases slightly or remains constant as pregnancy progresses and decreases postpartum. Since the accuracy of computing the surface area of pregnant women is questionable, the significance of the changes in vital capacity corrected for this factor is doubtful.

In a review of the literature on vital capacity in pregnancy, it is significant that every careful study based on *repeated observations* on the same patients showed an increase in the observed vital capacity during the course of pregnancy and a decrease postpartum, although the number of cases observed was small (Hasselbalch (23), 1 case; Root and Root, 1 case; Enright, Cole and Hitchcock (16), 7 cases). Rowe who studied 26 cases in the same manner found similar changes antepartum but his studies were incomplete since no postpartum observations were recorded. In addition, 30 compensated cardiacs studied in a similar fashion showed a similar increase in vital capacity during pregnancy (38).

It should be stated that most of the authors reporting a diminished vital capacity antepartum (Zhurakovski, Wintrich, Alward) made observations during the period immediately before delivery (usually within 1 week). In some of the cases of Root and Root and Enright, Cole, and Hitchcock most of which show a definite increase in vital capacity during pregnancy, there is evidence of a slight drop just before delivery. Unfortunately, no special study of that period was made here. However, it is highly possible that this factor may be responsible for the discrepancy in the literature. Other possibilities to explain the conflicting reports (Table I) may be one or more of the following sources of error:

1. Observations on different patients at different periods in pregnancy and the puerperium.
2. Insufficient period of time spent in observation.
3. Poor performance of the test by the patients studied.

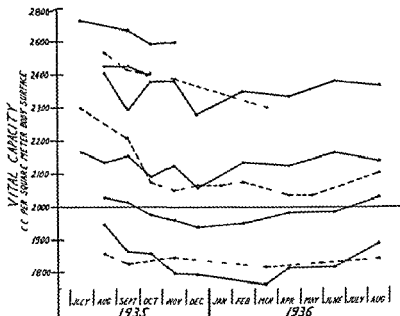


Fig 6 The vital capacity in cubic centimeters per square meter body surface area in 9 normal non pregnant women. The horizontal line represents the average normal vital capacity for women. The curves suggest a seasonal trend.

4 Presence of unrecognized intercurrent disease which may have influenced the vital capacity.

5 Failure to adhere to standard conditions for performing the tests.

These possible errors have been eliminated in this study.

Since the increase observed in the vital capacity in pregnancy is relatively small and not always constant the question of its significance arises.

In a group of normal non pregnant women (Fig 6) there is some fluctuation from observation to observation both above and below the mean while in pregnant women there is a slight but usually progressive increase before delivery with a sharp decrease by the second week postpartum (Fig 3).

The standard deviation of the normal non pregnant group when the variation around the mean of each individual patient is considered, is 58 cubic centimeters with a probable error of ± 30 cubic centimeters.

The total increase in average vital capacity in the pregnant women from the sixteenth to the fortieth week is $+102$ cubic

centimeters which is 2.6 times the probable error above.

The decrease in the vital capacity from the last average antepartum to the first average postpartum value is -138 cubic centimeters which is 3.5 times the probable error, the final postpartum value which is presumably the normal non pregnant value is -93 cubic centimeters which is 2.4 times the probable error.

Further when one compares the last antepartum value with the first, it is found that in 22 of 27 cases where data for comparison were present, the vital capacity is higher at the end of pregnancy. Thus plus the fact that in 24 of 31 cases the highest antepartum value is higher than the highest postpartum value, is additional evidence that there is an antepartum increase in the vital capacity with a postpartum decrease.

From the data presented it appears that the vital capacity certainly does not often decrease during pregnancy; it remains constant or increases reaching a maximum during the tenth month of pregnancy and diminishes postpartum.

The possible factors which might effect changes in the vital capacity during pregnancy should be discussed. These are: (1) training, (2) increase in body weight, (3) changes in chest volume, (4) changes in position and movement of the diaphragm, (5) changes in the residual air, (6) mobility of the thoracic cage, (7) changes in intrapleural and intra-abdominal pressures, (8) changes in the accessory muscles of respiration, (9) mechanical effect of the enlarged breasts and physiological effects of lactation.

Since the patients in this study had repeated observations made on them, the possibility of *training* being a causal factor was considered. This seemed unlikely since the last, i.e., the postpartum observations were not usually the highest ones. To exclude further this possibility, 9 normal non-pregnant women from 20 to 38 years of age (average, 28.6 years) who were followed at frequent intervals over a 14 month period failed to show a progressive increase in their vital capacities (Fig. 6).¹

Although there is a progressive *increase in body weight* during pregnancy, its increase is out of proportion to the increase in vital capacity. The effect of weight gain on the vital capacity of a normal individual is not known and data on this point could not be found in the literature. The similar increase and decrease in both during the course of pregnancy and the puerperium (Fig. 2) although disproportionate suggests a possible relationship.

It has been shown by Zhurakovski, MacKenzie, and others that the *circumference of the chest* increases in pregnancy about 5 to 7 centimeters which finding has been substantiated in this study. It has also been demonstrated by Klawns and Palugay that the anteroposterior and transverse diameters of the chest are increased while the long diameter is usually decreased which was also true of those measured in this study. The subcostal angle increases during pregnancy. *The correlation between the increase in vital capacity and the increase in subcostal angle is striking (Fig. 5)*

¹These observations on the normal non-pregnant group suggest the possibility of a seasonal variation in vital capacity. The data on the normal pregnant women presented here were analyzed to determine if the increase noted during pregnancy was caused by seasonal trend. Such was not the case.

and indicates that the change in vital capacity is linked with change in chest configuration.

It has been shown by Kountz and Alexander that the vital capacity in patients with emphysema can be increased by elevating the diaphragm by means of a specially designed abdominal belt. Thus it can be seen that an elevated diaphragm does not invariably mean reduced vital capacity, as commonly supposed, but may actually tend to increase it. Such a factor may operate in pregnancy. The mechanism by which this increase is brought about is not known but may be associated with reduction in the volume of *residual air* and hence an increase in vital capacity. This explanation of the increase in vital capacity in pregnancy has been suggested by Hasselbalch (23).

The relative *mobility of the thoracic cage* has been shown by Peabody and Wentworth to be a factor in vital capacity value. A study now being conducted by Gorman and Thomson indicates that there is more mobility in the sternomanubrial joint during pregnancy than in the puerperium. That this may be due to "relaxin," the hormonal substance shown first by Hisaw to affect the symphysis pubis of the pocket gopher, later purified by Fevold, Hisaw and Meyer, and recently demonstrated by Abramson (1) in the blood of women as early as the tenth week of pregnancy, is a possibility. Further evidence that the change in the chest configuration is possibly under hormonal control is the observation that the subcostal angle begins to widen, as did the symphysis pubis in the studies of Abramson, Roberts and Wilson (2) earlier in pregnancy than could be accounted for satisfactorily by mechanical pressure of an enlarging uterus.

Changes in both the absolute *intrapleural and intra-abdominal pressures* or in a ratio of one to the other might be a factor in producing vital capacity changes in pregnancy and puerperium, but there are insufficient observations on this point.

The influence of pregnancy on the *accessory muscles of respiration* is not known. It is conceivable, however, that one of the important factors in the rather marked decrease in vital capacity immediately postpartum is a change

in tone and lack of efficiency of the accessory muscles of respiration, particularly those of the abdomen following delivery. That this decrease is not due to effect of anesthesia and general operative manipulation is shown by the work of Churchill and McNeil who demonstrated that vital capacity decreases only in postoperative patients with abdominal incisions.

The mechanical effect of the enlarged breasts during pregnancy, particularly postpartum, and the actual physiological changes associated with lactation may be important factors in the postpartum decrease in vital capacity. Further understanding of the physiology of lactation is necessary to clarify this point.

One might expect, from the foregoing consideration of the factors which tend to increase the vital capacity during pregnancy, a greater increase in vital capacity than is actually observed. This relatively small increase, however, may well be the net resultant of forces. On the one hand most of the factors discussed would tend to increase the vital capacity. On the other hand the effect of the increase in volume of the pulmonary vascular bed in pregnancy would tend to diminish the vital capacity. That there is an increase in volume of the pulmonary vascular bed in pregnancy is evidenced by x ray and fluoroscopic examination of the lungs (34) and by histological examinations of Hofbauer who described around the branches of the fine bronchioles marked congestion of the vessels and peribronchial infiltration, chiefly with lymphocytes. In most cases, the first set of factors must predominate.

This study suggests

1 Since the vital capacity does not as commonly supposed, decrease spontaneously during normal pregnancy, a significant decrease during pregnancy must be explained by some pathological state.

2 The "dyspnea of pregnancy" can not be explained as it commonly is by a decrease in vital capacity. Dyspnea depends, as has been demonstrated by Peabody (32) and Harrison (20) largely on the ratio between vital capacity and pulmonary ventilation. A large increase in pulmonary ventilation with

only a slight increase in vital capacity to accompany it would lead to the development of dyspnea. This is precisely what happens in pregnancy. The pulmonary ventilation increases considerably, as is shown by several observers among whom are Anthony and Hansen (5) who demonstrated an average 57 per cent increase.

That the irritability of the "respiratory center" is heightened, as shown by Hasselbalch (23), is of further interest in a consideration of the "dyspnea of pregnancy." And finally it is reasonable to speculate that the altered lungs of pregnancy (25) may through the mechanism of reflex dyspnea from the congested lungs, described by Harrison, Calhoun, Cullen, Wilkins, and Pilcher lead to increased ventilation and dyspnea.

CONCLUSIONS

1 The vital capacity in normal pregnant women is within the limits set as normal for non pregnant women.

2 During the course of normal pregnancy the observed vital capacity usually remains constant or shows a slight increase.

3 The observed vital capacity decreases after delivery in most cases.

4 There is an increase in the subcostal angle during pregnancy, with a postpartum decrease.

5 The increase in vital capacity during pregnancy parallels closely the increase in subcostal angle value, as does the postpartum decrease.

6 The change in vital capacity in pregnancy is associated with alterations in the size and shape of the chest.

7 The increase in the observed vital capacity in pregnancy is not proportionately as great as the increase in body weight and approximate surface area.

8 The vital capacity in the lying position during pregnancy is approximately 5 per cent less than in the sitting and standing positions, but changes in a similar way.

9 The vital capacity in the standing position during pregnancy is slightly higher than that in the sitting position.

10 Age and parity have no apparent effect on the vital capacity in pregnancy.

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BILIARY DISEASE IN YOUNG SUBJECTS

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THE increased consideration being shown gall bladder disease in children as evidenced by the many papers and case reports that have appeared in the literature since the publication of my original article¹ is indeed gratifying. While some writers still claim the occurrence to be exceedingly rare a greater number have conceded it to be far more prevalent than was formerly thought.

It is not my intention to infer that the disease is as common in childhood as in adult life, yet I do contend that had gastrointestinal disturbances, icterus, and other symptoms in children received the same consideration that like symptoms would have received in adults, many cases of gall bladder disease would not have escaped recognition.

In my estimation early recognition and early treatment are not only essential for the patient's immediate relief, but more particularly to avoid the possibility of disease of the liver in later life. I am firmly convinced that at the present time, gall bladder surgery in children is several years in arrears of the symptoms. This is emphasized by the fact that a large majority of cases of gall bladder disease in the third and fourth decades give histories of symptoms dating back to the first or second decade.

It is interesting to note that the more recent textbooks on pediatrics do not show this condition in children to be a pathological curiosity of little or no importance. The subject deserves and is receiving more intensive study. It is my belief that in the future with the application of advanced methods, a greater number of diagnoses will be made pre-operatively and a lesser number at necropsy.

The writer has since his previous report, personally observed 6 verified cases of gall bladder infections in children not over the age of 15 years, the case reports of which are included herewith. Case 1 is typical of many to

be found in the literature supporting the theory that very often biliary disease originates in the early years of childhood.

Bearing in mind the fact, established by clinical study and observation, that the best results in gall bladder surgery are effected in young subjects, and that postoperative complications are most apt to occur and postoperative indigestion and pain are most apt to continue in patients who have surgery in later life, every effort should be exerted toward a correct pre-operative diagnosis. This should not be difficult. The history and classical findings are usually typical. In reviewing the numerous cases on record, one gains the impression that had the possibility of a biliary tract disease been entertained the diagnosis could have been, in most instances, correctly made.

In 1928, based on personal observations and collected data, I succeeded in establishing gall bladder disease in young subjects as a possibility not to be ignored. This was wholly inconsistent with the tenor of the textbooks and general medical opinion, but was supported by a tabulated list of 228 cases, including 4 of my own taken from the literature between 1722 and August 1927. The upper age limit was placed at 15 years. Beahm also in 1928 published a list of 60 cases, 17 of which were not included in my report. I have been able to collect an additional 25 cases from the literature of the years prior to 1928.

A search of the literature from August, 1927 through July, 1937 and personal communications and observations have revealed 162 cases, which when added to the 42 prior to 1928 and not included in my previous report bring a grand total of 432 cases.

Surely this large number of cases proves that gall bladder disease in children is by no means uncommon. Were all observed cases reported and added to the incalculable number diagnosed and treated as other pathological conditions the incidence would be greatly increased. Biliary tract disease in young children is therefore an entity which should be

¹Gall bladder disease in young subjects. Surg. Gynec. & Obst. 1928 46: 795-803.

suspected when clinical symptoms consistent with it are present and cannot be satisfactorily accounted for by other pathological conditions. After such elimination, special tests for biliary tract disease should be applied.

There is little to be added to what has already been said regarding the incidence of gall-bladder disease in children. However, certain aspects of the etiology, symptomatology, and diagnosis might be stressed.

ETIOLOGICAL CONSIDERATIONS

There can, I think, be little doubt that infectious disease of some part of the digestive tract is one of the principal causes of gall-bladder disease in children. Typhoid fever has been mainly incriminated. Since the incidence of typhoid in the United States has greatly diminished with no relative change in the incidence of gall-bladder disease, one must look for other contributory factors such as infections of the upper respiratory tract, including influenza and pneumonia, scarlet fever, appendicitis, intestinal parasites, and sometimes a history of abdominal trauma (Table I).

Cholecystitis may also be a complication of the systemic infections of childhood. A moderately large number of cases have been observed in the convalescent stage of scarlatina: Schottmueller details 5, Saxl and Gross and Ssawrimowitsch report similar instances. Schottmueller associates hepatitis with the cholecystitis in his cases, and believes that the toxin of the hemolytic streptococcus and not the microbe itself affects the liver and gives rise to the complication.

We must not overlook the possibility of a congenital origin of biliary tract disease, as illustrated in the cases of Melchior, of Brooks, and of Dotti.

Zelditch, et al. in some of the cases observed by them, associated cholecystitis with lambdasis, the latter being the etiological factor of the former.

SYMPTOMS

When biliary tract disease exists in children, the symptoms, in most cases, are the same as in adults. Young children, unable to describe their symptoms accurately, are inclined to complain only of abdominal pain not

TABLE I.—BUREAU OF CENSUS REPORT* ON ETIOLOGY, AGE, SEX, RACE

A. Deaths in children under 15 years of age from causes considered etiological factors in biliary tract disease, in white, negro, and other races

	Males	Females	Total
Infectious and parasitic diseases	13,201	12,807	26,008
Appendicitis	1,767	1,427	3,194
Influenza, respiratory complications specified	1,277	997	2,274
Scarlet fever	949	843	1,792
Typhoid fever	248	280	528

B. Deaths from biliary calculi in children not over 15 years of age, including males and females, white and others, none

C. Deaths from other diseases of gall-bladder and biliary passages in children not over 15 years of age

		Under 1 yr	1 yr	2 yrs	3 yrs	4 yrs	5 to 9 yrs	10 to 14 yrs	Total
Males—	white	4	0	4	2	2	4	2	18
	negro	0	1	0	0	1	1	1	4
Other races		0	0	0	0	0	0	0	0
Females—	white	1	3	0	2	1	1	4	12
	negro	1	0	0	0	0	0	1	2
Other races		0	0	0	0	0	0	0	0

*The Bureau of Census report on deaths by age, sex, and color or race in the Registration States (including District of Columbia), 1920 to 1934 (*Vital Statistics—Special Reports*, 1936, 1: 86)

localized, rather than to describe the classical symptoms. Thus, unless the physician has some suspicion of gall-bladder disease he is likely to err in diagnosis.

Zelditch and his associates made a thorough clinical investigation of 34 cases of mild cholecystitis in children, and state that in the majority, abdominal tenderness found in the subcostal region was more accurately localized either midway between the right costal margin and the umbilicus, or at the very edge of the ribs between the right mammillary zone and the scaphoid process. In about half their cases, the liver was found to have become enlarged.

Localized pain at the umbilicus is a predominant symptom in a vast number of cases.

DIAGNOSIS

The diagnosis of biliary tract disease in children is not difficult if the condition is suspected and the customary clinical and laboratory tests are applied.

TABLE II—STATISTICAL ANALYSIS—COMPARISON OF COLLECTED CASES OF 1928 AND 1937

Age incidence	No. of cases		Percentage	
	1928	1937	1928	1937
Fetal	2	0	87	0
Neonatal	20	4	9	2
Infancy	37	28	16	17
1 yr. to 5 yr.	26	30	11	43
5 yr. to 10 yr.	59	50	25	30
10 yr. to 15 yr.	84	52	37	31
Diagnosis				
By symptoms	21	75	9	46
Operation	128	73	56	43
Autopsy	9	16	34	10
Sex incidence				
Males	62	58	27	35
Females	76	73	33	44
Not stated	90	33	39	10
Of stated cases				
Males	62	58	44	44
Females	76	73	55	56
Cholelithiasis				
Present	141	65	62	30
Absent	48	60	21	36
Not stated	39	39	16	23
Of stated cases				
Present	141	65	74	51
Absent	48	60	25	43
Sex—when present				
Male	59	24	39	37
Female	85	41	60	62
Calculus in ducts				
Cystic	14	5	6	3
Common	13	4	5	2
Hepatic	0	1	0	5
Not stated	201	154	88	93
Sex—cystic				
Male	2	2	15	43
Female	12	3	84	57
Sex—common				
Male	6	2	44	50
Female	7	2	55	50
Jaundice				
Present	141	68	62	41
Absent	48	47	21	6
Not stated	39	50	16	31
Of stated cases				
Present	141	68	74	57
Absent	43	46	25	43
Sex—when stated				
Male	80	39	57	38
Female	61	29	42	41
Cholecystitis				
Present	118	111	52	67
Absent	19	9	8	5
Not stated	91	44	39	27
In association with				
Calculus	3	33	31	27
Jaundice	14	26	11	23
Calculus and jaundice	9	14	7	12
No calculus or jaundice	18	01	43	36
Sex incidence				
Male	37	45	31	42
Female	27	58	23	50
Not stated	54	8	45	7
Of stated cases				
Male	37	47	57	45
Female	27	56	42	54

Usually when a child complains of persistent abdominal pain found on investigation to be localized in the right subcostal or epigastric region, even in the absence of clear-cut symptoms, the condition is diagnosed as appendicitis, indeed, if such pains are noted as atypical, they are considered as referred.

Many of the cases reported in the literature were diagnosed as appendicitis and the patients operated upon before the true condition was revealed. However, other conditions in children may give rise to abdominal pain. Before diagnosis is made, tuberculous peritonitis, intestinal parasites, and other gastro intestinal diseases should be taken into consideration.

All the children in the cases studied by Zelditch, et al., with persistent abdominal pain were subjected to duodenal intubation routinely, as well as examination of bile, of gastric contents of feces, and to x ray examination of the tract. The examination of bile was very helpful in diagnosing biliary tract disease. In most cases changes were observed in bile A, B, or C, the bile containing flakes of mucus, fine or coarse the latter usually containing many leucocytes. The bile was apt to contain cholesterol when there was a tendency to cholelithiasis. Simultaneous changes in bile A and bile B denoted simultaneous changes in the gall bladder and biliary passages. When bile C was changed, there was usually an affection of the liver. Inflammatory changes in bile C suggested cholangitis.

In cholecystitis the blood examination usually revealed slight leucocytosis and when intestinal parasites were present their ova were usually found in the feces, also in bile A and bile B occasionally when lamblia was associated with cholecystitis.

The most effective means of arriving at a correct diagnosis of biliary tract disease when it is suspected in children appears to be cholecystography. Graham states that in the St. Louis Children's Hospital, since the development of this diagnostic method, several cases in children under 15 years of age, some of them infants, have been confirmed by operation, some with stones, some with icterus, and some with catarrhal icterus. There were also a considerable number of cases diagnosed as chronic cholecystitis which were not sub

mitted to operation. Besides Graham, Velo, Beals, Rudisill, Montgomery, Shawan and Long, McClendon, and Holbrook were able to make correct pre-operative diagnoses by means of the cholecystograph

TREATMENT

A word should be said regarding treatment. While in advanced cases the classical cholecystostomy or cholecystectomy must be the method of choice, Zelditch and associates state that in mild cholecystitis cases the patients usually recovered following duodenal intubation and rest, and that only a few of such patients had to return to the clinic owing to recrudescence of the abdominal pains. Medicinal and dietary measures and rest are often effective in the more mild cases, but if symptoms persist surgical intervention is indicated.

I wish to report the following 6 cases of interest which have come under my personal observation during the past 10 years:

CASE 1. A poorly developed white boy aged $7\frac{1}{2}$ years entered the hospital December 20, 1930, appearing to be acutely ill. He was lying in bed, knees flexed, and suffering with a generalized pain over the entire abdomen. The skin was markedly jaundiced. Patient was dehydrated. The tongue was red and dry, the skin hot to the touch. He had had many attacks of gastro-intestinal upsets with abdominal pain, nausea, vomiting, and jaundice at irregular intervals since 2 months old. It was my privilege to see this boy when he was $2\frac{1}{2}$ months old during such an attack, but the symptoms were of a milder type, and were seemingly confined to the gall bladder. I have seen him many times since. The present upset is more severe, and points not only to the gall bladder but to the appendix as well. The patient has been ill for the past 5 days with colic-like pains in the abdomen, diarrhea, constipation, acholic stools, anorexia, nausea, and vomiting. Examination reveals chest negative, abdomen, distended with rigidity of muscles and very tender on palpation over McBurney's point and gall-bladder areas. Temperature was 102 degrees, pulse, 120, respiration, 28. Blood count showed hemoglobin, 67 per cent (Dare), leucocytes, 12,450, polymorphonuclears, 76 per cent. Urinalysis revealed: specific gravity, 1022, albumin, +, acetone, slight trace, heavy trace of bile. Wassermann and Kahn tests were negative, van den Bergh, immediate direct reaction positive. A cholecystograph revealed a shadow indicative of the gall bladder, accepting the Graham dye very well. Gall bladder not enlarged, outline was regular, with evidence of the presence of calculi within the shadow. A diagnosis of chronic cholecystitis, cholelithiasis, and acute appendicitis was made.

Operation was performed December 21, 1930. A right paramedian incision was made extending from 2 inches above to 2 inches below the umbilicus. The peritoneal cavity contained a small amount of serous fluid. The gall bladder was distended, with thickened wall and a marked degree of inflammation. Calculi were easily palpated. With the history of many previous attacks, a cholecystectomy was considered advisable. The appendix was rather high, surrounded by the omentum, and revealed a very acute inflammation. An appendectomy was also done. One drainage tube was inserted through the upper angle of the incision to the former bed of the gall bladder. Another drain was inserted through the lower angle of the incision to the pelvis. The patient's convalescence was a bit stormy, although he made a complete recovery. Final diagnosis acute cholecystitis, cholelithiasis, and acute suppurative appendicitis.

The pathological findings showed an acute cholecystitis and an acute suppurative appendicitis. The gall bladder contained 20 small faceted calculi. A bile culture showed mixed infection.

Patient was discharged January 10, 1931. On January 3, 1937, he was enjoying very good health, and has had no disturbance since his discharge from the hospital.

CASE 2 (This patient was seen in consultation with the late Dr. J. H. Poulton.) A fairly well developed white boy, aged 8 years, entered the hospital November 17, 1930. He appeared to be ill, but not seriously, suffering with diffused pains over the entire abdomen, although there was more tenderness on palpation in the right hypochondriac region. The abdomen was slightly distended, no rigidity of abdominal muscles, but some spasticity of right rectus below the right costal arch. The sclera and skin were icteric. The onset of present illness began 1 week ago, with abdominal pain, nausea, and vomiting. The boy was ill for 2 days, then was permitted to get up and play for 2 days, after which his condition became worse and he was put to bed. He was constipated at first, but at this time the bowels were loose and the stools acholic.

His general health had been good. Patient had had the usual diseases of childhood, but no serious illness. The tonsils were hypertrophied. There were no other symptoms than the abdominal pain, nausea, and tenderness on palpation over the gall-bladder area. The skin and sclera were icteric. Physical examination was essentially negative.

Temperature was 99.8 degrees, pulse, 88, respiration, 20. The Widal test was negative, Wassermann and Kahn, negative. Blood count revealed hemoglobin, 75 per cent; red blood cells, 3,750,000; white blood cells, 8,960, small lymphocytes, 36; large lymphocytes, 2; coagulation time, 2 minutes; polymorphonuclears, 62 per cent. Urinalysis revealed: color, dark amber; appearance, cloudy; specific gravity, 1022, reaction, acid, albumin, +, sugar, 0; acetone, slight trace, diacetic acid, slight trace; bile, heavy trace, casts, 0, cylindroids, occasional; leu-

cocytes few, mucus moderate amount Fouchet positive, van den Bergh immediate direct reaction positive

Cholecystography revealed a shadow indicative of gall bladder accepting Graham dye very poorly. The gall bladder was evidently much larger than normal size but of regular outline, with no signs of the presence of a foreign body. Its appearance suggested a possible hydrops of the gall bladder.

The patient remained in the hospital for a week under medical treatment and improved. He was discharged November 24 1930. Diagnosis acute cholecystitis and cholangitis, hydrops of gall bladder.

CASE 3 (This case was seen in consultation with Dr. H. H. Hildred.)

Patient entered the hospital January 10 1930. A white male, aged 8 years, well developed and nourished, lying quietly in bed but complaining of some pain in the head and abdomen with maximum tenderness above and to the right of the umbilicus. The skin and sclera were jaundiced. Patient had complained of pain around the umbilicus for the past 3 or 4 days; the pain at first being severe enough to make him double up. This was continuous for several days and was accompanied with nausea and vomiting. Jaundice appeared after the first 2 days. The bowels were at first constipated but became more free. The stools were of a very light yellowish color. For the past several days, any fluids even water would induce nausea and vomiting. Pain in the abdomen was subsiding when patient entered the hospital. Patient had anorexia for 4 or 5 days but stated he was hungry.

Patient had had measles, mumps, scarlet fever, varicella and pneumonia twice. Tonsillectomy and adenectomy were done 2 years ago.

With the exception of jaundice, brownish red urine, several carious teeth, abdominal pain and slight distention, and a palpable mass the size of a hen's egg in upper right quadrant, there were no outstanding signs or symptoms. General physical examination did not reveal any disturbances of heart or lungs. As a matter of fact, examination was essentially negative.

Temperature was 99.4 degrees, pulse 82, respiration 20. Throat culture revealed Greening streptococcus and staphylococcus, no diphtheria forms. Blood count showed hemoglobin 82 per cent, red blood cells, 4,120,000, white blood cells 6,300, color index 1.0, coagulation time 13½ minutes. Urinalysis revealed color brown, specific gravity 1.025, reaction, acid, albumin 0, sugar 0, acetone, 0, bile slightly positive, epithelia small amount, mucus present, bacteria present, Wassermann and Kahn tests were negative, Fouchet positive, van den Bergh immediate direct reaction, positive.

Radiographic examination showed no evidence of obstruction of the intestines, large or small. The gall bladder did not take Graham dye but its shadow seemed larger than normal.

Diagnosis cholecystitis, acute catarrhal jaundice, cholangitis (?).

Patient remained in the hospital 11 days under treatment and was discharged January 21 1930 with a promise to return should any other disturbance arise. Patient's condition improved. He had one attack since leaving the hospital with very pronounced gall bladder symptoms. Will eventually be operated upon.

CASE 4. Patient a white female, aged 11 years, entered the hospital January 25 1930. When first seen, she was lying quietly in bed in no apparent distress. She was a well developed and well nourished child but deeply jaundiced. Temperature was 99 degrees, pulse, 72, respiration 20.

One week ago the patient began to have anorexia and became drowsy and sleepy. She complained of pain in the upper right quadrant (costal margin) anteriorly, also of pain in the lumbar region of the back. She had epigastric pain which seemed to be worse in the evening, dull and present at intervals. She was jaundiced from the beginning. The stools were clay colored, the urine yellow, but there was no pruritus.

Patient had had measles and mumps but no serious illness. She had had occasional frontal head aches and nose bleeding. She had recently recovered from a mild attack of influenza.

Head, eyes, nose, ears, and neck revealed nothing remarkable. Oral hygiene was poor and she had several carious teeth. Her heart had a soft, systolic murmur. There was no increased cardiac dullness. Lungs showed equal expansion on both sides. A few râles could be heard on deep inspiration anterior and posterior over both lungs, both lobes otherwise negative. The abdomen showed some slight distention. There was tenderness on palpation at the right costal margin anteriorly. The liver was not palpable. There were no palpable tumors or masses, no other tenderness. Reflexes were present and equal. No glandular adenopathy was noted. The skin was deeply jaundiced. Menstrual periods were regular of 28 day type and of 5 to 6 days' duration.

Throat culture revealed Greening streptococcus, no diphtheria forms. Urinalysis revealed color amber, specific gravity 1.012, reaction acid, specific gravity hazy, albumin 0, sugar 0, acetone 0, bile present, casts 0, leucocytes small number, epithelia small amount, bacteria, loaded. Blood examination revealed hemoglobin 76 per cent, red blood cells 4,300,000, white blood cells 9,000, no leucocytosis, 40 per cent with shift to left of 12 per cent. Kahn and Wassermann test gave negative reaction for syphilis, van den Bergh immediate direct reaction positive, Fouchet positive.

Diagnosis acute cholecystitis with jaundice. CASE 5 (This case seen in consultation with Dr. H. H. Hildred.)

A fairly well developed and nourished white female, aged 9 years, was admitted to the hospital January 15 1930. Five days previously she complained of pain in the upper right quadrant of the abdomen, anteriorly, anorexia, vomiting and con-

stipation. The patient had a temperature, the skin and sclera were deeply icteric, and the stools were clay colored. She had on previous occasions had similar symptoms. Past history revealed that patient had had measles, mumps, pneumonia, and more recently influenza. The patient's parents state that the child has been jaundiced with upset stomach quite a number of times; and in fact, that she first became jaundiced 2 weeks after birth.

Examination revealed tenderness over the entire abdomen, more marked in the upper right quadrant, and especially to the right of, and above, the umbilicus, with some distention. There was marked rigidity of the right rectus muscle in the upper right quadrant with some spasticity. The skin and sclera showed marked icterus. The temperature was 100 degrees, pulse, 100; respiration, 32. The blood count showed hemoglobin, 75 per cent; red blood cells, 4,300,000, white blood cells, 8,900, polymorphonuclears, 78 per cent, lymphocytosis, 40 per cent with shift to the left of 12 per cent. Urinalysis showed specific gravity, 1022; color, dark amber, albumin, 0, sugar, 0, acetone, trace; bile, present. Throat cultures revealed Greening streptococcus, no diphtheria forms. Kahn and Wassermann tests were negative; Fouchet, negative, van den Bergh test, immediate direct reaction, positive 37.5 milligrams. Roentgenological examination of chest did not reveal any pathological condition.

Cholecystography revealed a shadow indicative of a gall bladder accepting Graham dye fairly well, very much larger than normal, outline regular. No signs of a foreign body were noted within the shadow. The appearance was that of a hydrops of the gall bladder. Oral hygiene was very poor. Other than the foregoing, the physical examination was essentially negative.

Diagnosis of acute cholecystitis (hydrops), with jaundice.

The patient's parents steadfastly refused to have any surgical intervention, and the patient remained in the hospital under treatment for 11 days when she was discharged improved, with the understanding that she was to return at some future date.

Information has come to us that subsequent to the family's moving away from the city, the patient had a recurrence with similar symptoms at which time she was operated upon. The diagnosis was chronic cholecystitis with hydrops and subacute appendicitis.

CASE 6. (This case was seen in consultation with Dr. H. B. Martin. The writer was also present at the autopsy.)

Patient was a white male, a 7½ months premature infant, weighing 4 pounds 10½ ounces. He was born March 12, 1932, 4:25 p.m.—delivery was uncomplicated.

Patient was undernourished with skin and sclera deeply jaundiced. The abdomen was somewhat distended. Pulse was rather feeble; temperature, 97. There was some slight difficulty in breathing at irregular intervals. Patient was put in an incubator

and at first seemed to improve, but gradually lost ground and died March 13, 1932, at 6:50 p.m., when 26 hours old. It was believed the patient had some congenital abnormalities which caused the condition.

Autopsy on March 14, 1932, 9:30 a.m. revealed the following: The body is that of a premature white male child, 26 hours old. The hair is light and the body is deeply jaundiced. The child measures 42 centimeters in length and weighs 4 pounds 5 ounces. There are no malformations or special marks of identification. The child is 6 weeks premature.

Abdominal cavity. When the abdomen was opened, the peritoneal cavity was found to contain a small amount of yellowish fluid. The liver was large as was also the spleen, but the enlargement did not exceed the normal limits for baby of this age. Upon cut section, the liver was found to be soft, somewhat yellowish, but otherwise not remarkable. The gall bladder was distended, quite tense, and larger than normal. The wall was thin and appeared edematous, and did not empty under pressure. The gall bladder was opened and found to contain a quantity of thick, white bile. The cystic duct was distended and a probe was easily passed into the common duct, where an obstruction was met. The duct was opened at this point and there was seen an atresia with the wall thickened. The stomach and pylorus were normal as was the entire gastro-intestinal tract. The spleen was normal on cut section. The left kidney was of the usual size and the ureter was somewhat enlarged. The kidney was opened and the pelvis was found dilated and filled with urine under pressure. The right kidney was entirely similar and the right ureter was enlarged. The adrenals were normal. The bladder was normal and no gross evidence of obstruction was to be found.

Thoracic cavity. The thymus was of normal size. The cardiac area was not enlarged and the lungs showed a nearly complete exhaustion with a few scattered areas of petechiae. There was no obstruction to the trachea or bronchi. Upon examination of the heart, the coronary arteries especially those of the right descending branch, were found to be thickened in an irregular manner, but this thickening appeared grossly to be of the adventitial type. The heart was not enlarged and presented no abnormalities.

Cranial cavity. There was an extensive edema of the brain with a yellowish accumulation of fluid beneath the dura. The brain itself was not remarkable, however, and the meningeal vessels were somewhat congested.

Anatomical diagnosis: (1) Prematurity. (2) Bilateral congenital hydronephrosis. (3) Hydrops of gall bladder. (4) Atresia of common duct. (5) Thickened coronary arteries. (6) Edema of the brain.

Microscopical sections. (1) Sections of the heart show a normal myocardium and an adventitial thickening of the coronary arteries. (2) Section of the lungs shows partial atelectasis, but no other noteworthy pathology. (3) Sections of the spleen show

an abnormal amount of blood pigment indicating an excess hemolysis of blood cells. The endothelial and lymphoid structures are not remarkable. (4) Sections of the gall bladder and common duct do not show any remarkable pathological condition excepting a hemorrhagic infiltration of duct. (5) Section of the kidneys shows some hemorrhage into a few of the glomeruli but no evidence of infection. (6) Sections of the liver are remarkable showing a marked central necrosis with small accumulation of pus cells and hemorrhage and degenerated blood cells around the periphery of the lobules which process has practically destroyed the liver structure so that the usual arrangement of liver cells is obscured. (7) Sections of the bladder are not remarkable. Final diagnosis—causes of death: (1) hydrops of the gall bladder, (2) stenosis of the common duct, (3) acute necrosis of the liver, (4) marked hemolysis of blood in the spleen, (5) bilateral hydronephrosis, (6) partially expanded lungs, (7) inflammatory sclerosis of the coronary arteries, (8) edema of the brain, (9) prematurity, (10) jaundice.

CONCLUSIONS

Beginning with a report by Gibson, in 1722, we have been able to collect a total of 270 cases in the 205 years ending in 1927—an average of approximately $1\frac{1}{2}$ cases per year. In the following 10 years we were able to collect 162 cases, or an average of 16 per year, an increase of 12 to 1. If the next 10 years show a corresponding increase, as is highly probable with the application of improved diagnostic measures biliary disease will have become firmly fixed as a pathological condition existing in young subjects.

It is interesting to note an increase of 500 per cent in the number of cases diagnosed by symptoms, and a decrease of 71 per cent in the number diagnosed at necropsy. As in adults, females are in slight excess of males.

Suffice it to say that the statistical summary verifies the fact that great progress is being made and that fewer and fewer cases of gall bladder disease in children will escape recognition.

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VISCERAL METASTASIS FROM RECTAL CARCINOMA

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ONE disturbing feature in the end-results of radical resections for carcinoma of the rectum has been the all too frequent development of visceral metastases. This is no reflection upon the present types of resections designed to remove adequately the local tumor within the limits of anatomical feasibility. Pre-operative x-ray examination of the lungs and careful inspection and palpation of the liver at laparotomy may sometimes demonstrate already existing visceral metastases. Enlarged local lymph nodes may be hyperplastic or neoplastic, and differentiation must often wait on microscopic examination.

Attempts to anticipate metastasis and recurrence by examination of the surgical specimen have been based largely on involvement of lymph nodes and on histological tumor grading. In rectal carcinomas the nodes have been disappointing indicators because visceral metastases often occur independently of neoplastic lymph nodes. The local growth, however, offers another harbinger of organ metastasis, namely invasion of the veins and capillaries by tumor.

The present study of 170 rectal carcinomas with complete postmortem findings attempts to evaluate the importance of local blood vessel invasion as compared with neoplastic lymph nodes in predicting the occurrence of visceral metastases. Incidental to this, we have noted the influence of such factors as the histological type, extent, and location of the primary growth, duration of disease, age, and sex, upon the development of visceral metastases.

The files of the New England Deaconess, the New England Baptist, the Pondville Hospitals, and the House of the Good Samaritan have furnished our material. This group of 170 cases, covering a period of nearly 10 years, was selected because it had detailed postmortem protocols and numerous microscopic slides of the local lesion. Constituting the series are cases of patients dying immediately after resection or colostomy, survivals after operation, and those cases in which no operation interrupted the natural course of the disease.

This series represents only a small portion of patients with rectal carcinoma treated in the above hospitals over the stated time period, and includes only a moderate number of the rectal cancer deaths during that period. Because of the selection imposed by the necessity of having postmortem examinations for this study, generalizations from the facts forthcoming should be made with some caution.

METHOD

Autopsy protocols of patients with carcinomas occurring within 15 centimeters of the anus, or having been removed from that site, were assembled. From the case records information on symptoms, operative procedures, surgical specimens, and postoperative course was tabulated. Data pertaining to location, size, and extent of the primary tumor, and lymph node metastases were recorded from the description of the surgical specimen. Slides were reviewed to confirm the diagnosis and to search for tumor growth into blood and lymphatic vessels.

The chances of error in vessel identification were slight, as nearly all tissues were both paraffin and celloidin imbedded, and after being sectioned, were stained with hematoxylin-eosin, phloxine-methylene blue, and phosphotungstic acid hematoxylin. As would be expected, difficulty was encountered in determining whether intravascular tumor foci present were in capillaries or lymphatics. The finding of erythrocytes in the lumen was of great aid in differentiation. In cases of doubt, decision was made against intravascular invasion. Careful examination of the perirectal fat frequently disclosed involved capillaries and venules. In patients unoperated upon the local findings were tabulated from the postmortem protocols and slides. Visceral metastases were checked and the causes of death noted (Figs 1 to 5).

DATA

The nomenclature employed to designate the various types of rectal cancer carries significance from the standpoint of tumor grading. The term malignant adenoma is used to designate those well differentiated glandular growths classed by many as grade I adenocarcinoma. Those classified as adenocarcinomas are tumors with moderate gland formation as well as solid cell masses

From Pathological Laboratories of New England Deaconess, New England Baptist, Huntington, and Pondville Hospitals.
Dr. Brown—Littauer Fellow in Pathology, Harvard Cancer Commission.



Fig 1 Focus of adenocarcinoma in a small vein. At one point a tumor cell is adherent to the intima. Note the accompanying artery. These vessels are in the perirectal fat 2 millimeters from the muscularis. $\times 185$

and invasiveness analogous to grade II. Carcinoma simplex is used to indicate tumors with scant or no alveolar formation, solid cell masses, marked invasion, many mitoses, and is consistent with grades III and IV. The colloid or more properly mucinous, carcinomas have in this site the clinical behavior of grades III and IV carcinomas. The epidermoid carcinomas included are those occurring about the sphincter. Seventy one of the primary growths were obtained as surgical specimens and 99 as autopsy specimens. In Table I all cases are arranged according to treatment.

The untreated cases are seen to constitute only 13.5 per cent of the total, and the resections comprise 42 per cent. This is a fair proportion con-

sidering that some patients were referred to these hospitals for terminal care. Dixon has reported that over 50 per cent of rectal growths are inoperable when first observed. By chance all the 9 patients with carcinoma simplex received some form of treatment. The anal location of the epidermoid cancers accounts, no doubt, for their general treatment. Comprising the radical operations are 46 one stage abdominoperineal resections, 9 two stage, and 16 posterior excisions.

The causes of death in the patients in the aforementioned treatment groups are tabulated in Table II. Four fifths of the resection deaths can be accounted for by conditions precipitated locally by radical removal of the growth, such as peritonitis, obstruction, shock, or hemorrhage. The causes of death from colostomy, on the other hand, seem concerned more with the general debility of the patient. Here pneumonia and pulmonary embolism account for 40 per cent of the colostomy deaths following operation. The relatively high incidence of pulmonary embolism from a simple procedure like colostomy suggests that systemic factors, such as debility, poor nutrition, poor aeration, and sluggish circulation are of etiological importance. Of the 26 resection survivors, 10 died without evidence of recurrence or metastasis. Late postoperative complications like obstruction and sepsis accounted for 6 of these deaths. In the table the patients not operated upon and the colostomy survivors were grouped together. About half of this group died of cachexia or exhaustion from widespread metastasis or local recurrence. A large portion of the remainder died of pneumonia occasioned, no doubt, by cachexia.

Single or multiple adenomatous polyps of the colon were associated with 18 or 11 per cent of the 165 glandular or adenoid carcinomas. This coincidence, although smaller than the 40 per cent reported by Westhues and nearly 50 per cent

TABLE I—SUMMARY OF TYPES OF CARCINOMA AND TREATMENT

Types	Resections		Colostomy	Non-operative	Total	Percent of total type resected
	Acute deaths	Survivals				
Malignant adenoma	9	3	2	6	4	3
Adenocarcinoma	31	4	4	4	100	45
Mucinous carcinoma	3	4	6	3	16	44
Carcinoma simplex	0	4	5	0	9	41
Epidermoid carcinoma	7	1	2	0	8	60
Total	45	6	19	3	170	47

Note: Acute resection deaths includes those deaths occurring with the first metastasis postoperatively. Recurrence survival includes those patients surviving the operation by colostomy.

TABLE II—CAUSES OF DEATH

	Shock	Hemorrhage	Peritonitis	Sepsis	Obstruction	Ileus	Pulmonary embolism	Pneumonia	Cachexia	Cardiac	Renal insufficiency	Pulmonary tuberculosis	Miscellaneous	Undetermined	Total
Deaths from resection	5	3	16	5	5	2	1	5	1	1	1	0	0	0	45
Deaths from colostomy	0	1	3	3	2	0	5	8	4	0	2	0	2	3	33
Resection survivals	0	0	1	4	2	0	1	1	6	1	9	1	0	0	26
Non-operation colostomy survivals	0	3	5	2	1	0	1	13	31	2	4	1	3	0	66
Total	5	7	25	14	10	2	8	27	42	4	16	2	5	3	170

reported by Susman is still significantly higher than the incidence of adenomatous polyps of the large intestine in general. Susman reported a 6 per cent incidence of polyps in 1100 consecutive postmortems, and Stewart reported 4.19 per cent in 1815 autopsies in which the colon was carefully scrutinized. In his series the latter also reported 10,985 previous autopsies in which no special search was made for polyps, and here the incidence was only 0.47 per cent. Faulty observation may account partially for the lower incidence of polyps with carcinoma in our series, although the colon was examined with moderate care in all cases.

The situation existing between colonic polyps and cancer is summarized by Karsner and Clark, who, after a brief but informative review, conclude that colonic polyps must be regarded as potentially malignant.

The number of visceral metastases with the number of cases occurring in each treatment group is tabulated in Table III.

The total visceral metastases for each type of growth is summarized next to the cases showing positive lymph nodes in the latter columns of the table. The 70 cases of lymph node metastases are not identical with those showing visceral metastases although there is some overlapping.

A total of 70 cases with visceral metastases among 170 seems small until it is realized that 45 deaths occurred within 1 month of resection, and 33 followed colostomy within a similar period. Inasmuch as the treatment accorded the various adenoid types (malignant adenoma, adenocarcinoma, mucinous carcinoma, and carcinoma simplex) was proportionately similar, the relative malignancy of the different types is reflected in the percentage visceral metastases in each. This is in accord with Rankin and Broders, and Stewart and Spies. Mucinous carcinoma, however, shows only 31 per cent visceral metastases. Expression of its malignant tendency must be sought in diffuse, local growth and in extensive lymphatic permeation due probably to mechanical pressure by the mucinous material. Support for this contention is at hand in the highest percentage lymph node involvement for all types—69 per cent. Even though fewer malignant adenomas were resected the occurrence of metastases to viscera and to lymph nodes was well below that for any of the other types of malignant growth.

The 6 patients with visceral metastases in the group of 45 resection deaths merit some comment. In 2 of these, metastases to the liver were noted at operation. In the 4 remaining, no metastases

TABLE III—VISCERAL METASTASES OCCURRING IN EACH TREATMENT GROUP

	Resections		Colostomy *V M	No Operation *V M	Total *V M	Percent *V M	Total cases with positive †L N	Per cent with positive L N
	Acute death *V M	Survival *V M						
Malignant adenoma	1 in 9	1 in 3	4 in 22	3 in 6	9 in 40	23	7	18
Adenocarcinoma	5 in 31	8 in 14	27 in 41	9 in 14	40 in 100	49	45	45
Mucinous carcinoma	0 in 3	0 in 4	3 in 6	2 in 3	5 in 16	31	11	69
Carcinoma simplex	0 in 0	2 in 4	3 in 5	0 in 0	5 in 9	56	4	44
Epidermoid carcinoma	0 in 2	1 in 1	1 in 2	0 in 0	2 in 5	40	3	60
Total	6	12	35	14	70 in 170	41	70	41

*V M—Visceral metastases. †L N—Lymph nodes.

Note: The last two columns include lymph node metastases for group comparison with visceral metastases.



Fig. 1. Focus of adenocarcinoma in a small vein. At one point a tumor cell is adherent to the intima. Note the accompanying artery. These vessels are in the perivascular fat 2 millimeters from the muscularis. $\times 185$.

and invasiveness analogous to grade II. Carcinoma simplex is used to indicate tumors with scant or no alveolar formation, solid cell masses, marked invasion, many mitoses and is consistent with grades III and IV. The colloid or more properly mucinous, carcinomas have in this site the clinical behavior of grades III and IV carcinomas. The epidermoid carcinomas included are those occurring about the sphincter. Seventy-one of the primary growths were obtained as surgical specimens and 99 as autopsy specimens. In Table I all cases are arranged according to treatment.

The untreated cases are seen to constitute only 13.5 per cent of the total and the resections comprise 42 per cent. This is a fair proportion con-

sidering that some patients were referred to these hospitals for terminal care. Dixon has reported that over 50 per cent of rectal growths are inoperable when first observed. By chance all the 9 patients with carcinoma simplex received some form of treatment. The anal location of the epidermoid cancers accounts no doubt for their general treatment. Comprising the radical operations are 46 one stage abdominoperineal resections, 9 two stage and 16 posterior excisions.

The causes of death in the patients in the aforementioned treatment groups are tabulated in Table II. Four fifths of the resection deaths can be accounted for by conditions precipitated locally by radical removal of the growth, such as peritonitis, obstruction, shock, or hemorrhage. The causes of death from colostomy, on the other hand, seem concerned more with the general debility of the patient. Here pneumonia and pulmonary embolism account for 40 per cent of the colostomy deaths following operation. The relatively high incidence of pulmonary embolism from a simple procedure like colostomy suggests that systemic factors such as debility, poor nutrition, poor aeration, and sluggish circulation are of etiological importance. Of the 26 resection survivors, 10 died without evidence of recurrence or metastasis. Late postoperative complications like obstruction and sepsis accounted for 6 of these deaths. In the table the patients not operated upon and the colostomy survivors were grouped together. About half of this group died of cachexia or exhaustion from widespread metastasis or local recurrence. A large portion of the remainder died of pneumonia occasioned no doubt by cachexia.

Single or multiple adenomatous polyps of the colon were associated with 18 or 11 per cent of the 165 glandular or adenoid carcinomas. This coincidence although smaller than the 40 per cent reported by Westhues and nearly 50 per cent

TABLE I—SUMMARY OF TYPES OF CARCINOMA AND TREATMENT

Types	Resections		Colostomy	Non-operative	Total	Percentage type resected
	Acute deaths	Survival				
Malignant adenoma	9	3		6	40	30
Adenocarcinoma	31	14	4	14	60	45
Mucinous adenoma	3	4	6	3	16	44
Carcinoma simplex	0	4	5	0	9	64
Epidermoid carcinoma	2		2	0	5	60
Total	45	6	16	3	170	4

Note: Acute resection deaths include those deaths occurring within the first month postoperatively. Resection survival includes those patients surviving the operation by one month.



Fig 3 Penetration of wall of venule in rectal muscularis by tumor cells of carcinoma simplex. Blood cells can be seen within the lumen. An adjacent arteriole is shown also $\times 465$

vertebrae The inference from this heterogeneous group is that local extension may account for some, but not most of the bone metastases from carcinoma of the rectum. The fact that the vertebrae are the chief sites of skeletal metastasis for primary cancers in general supports this conclusion. Aufses in 1930 added 8 cases of skeletal metastasis from rectal cancer to 16 reported in the literature. His series totaled 117 cases, with 29 autopsies. Five of his 8 cases of skeletal metastasis were proved at autopsy.

Before discussing the conditions in the local growth which help to bring about visceral metastasis, we would like to consider briefly three general factors, namely: duration of symptoms of the disease, age, and sex.

The total symptom duration has been calculated for each case as the sum of the pre-operative symptom duration and postoperative survival period in months. The effect of disease duration on the incidence of visceral metastases in 86 cases of adenocarcinoma is shown in Chart 1. The 14 resection survivals were omitted because they represented duration without the primary focus.

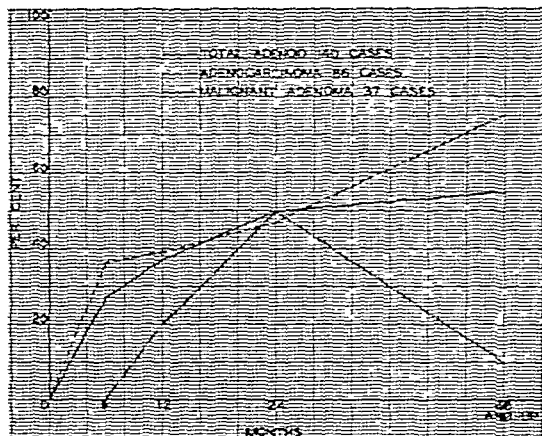


Chart 2. Symptom duration and percentage of visceral metastasis.

Here the percentage visceral metastasis is plotted against the average duration in months. The average duration for the 32 cases of adenocarcinoma dying at resection was 10 months, and 16 per cent of these showed visceral metastasis. Forty-seven per cent of the 17 colostomy deaths with an average duration of 13 months, and 74 per cent of the 38 colostomy survivals or non-operated upon patients averaging 27 months total duration showed visceral metastases.

Another method of summary has been applied to the adenocarcinomas, the malignant adenomas and to the total adenoid group (Chart 2). Arbitrary time periods of 6, 12, 24, and 48 months were adopted, and the visceral metastases in cases falling into these duration groups were tabulated for each type of growth. Resection survivals were omitted as above.

The duration in months is plotted against the percentage visceral metastases. This method of computation puts rather rigorous demands upon duration as influencing visceral metastasis since each duration period is non-cumulative. The type of surgical intervention here is of little moment because the primary tumor was present throughout the disease. Since colloid carcinoma and carcinoma simplex constitute only 17 cases eligible for consideration here, they were included in the adenoid group without being given special consideration. In the method mentioned an obvious source of error is the date set for the origin of the growth. Miles has estimated definite time periods as determined by the progress of the growth around the bowel wall, but so many of our cases were already annular that we have judged the duration onset arbi-

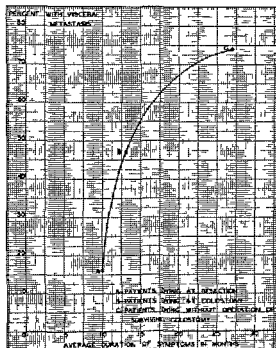


Chart 1 Symptom duration and percentage of visceral metastases

were noted in the liver. Thus 9 per cent of resected cases had no discernible visceral metastases at the time of operation. Two of these patients had occult liver metastases and 2 had lung metastases. In 3 of these 4 cases the local tumor was found at operation to have extended to a pelvic viscus.

There seems to be very little doubt that the broader the criteria for operability, the greater will be the number of cases with hidden metastases included. This inevitable handicap to surgical treatment, however, is relatively small and should in no way be construed to discourage an attempt at cure or palliation through wide resection.

TABLE IV—LOCATION OF METASTASES IN 70 CASES WITH VISCERAL INVOLVEMENT

Cases	Cases
Liver 57	Ovary 2
Lung 38	Heart 2
Adrenal 19	Skin 2
Bone 13	Muscle 2
Thyroid 4	Gall bladder 1
Kidney 4	Colostomy 1
Intestine 4	Brain 1
Spleen 4	Appendix 1
Pancreas 3	Pleura 1



Fig. 2 Small focus of adenocarcinoma adherent to the wall of a capillary. Note the erythrocyte within the lumen. $\times 425$

The chief sites of visceral metastasis in the 70 cases are as follows: liver, 57 times; lung, 38 times; and adrenal, 19 times (Table IV). Eighty-one per cent of the patients with metastasis to an organ showed liver involvement. Metastasis to the liver alone occurred 23 times and to the lung alone 6 times. In all patients with lung metastases alone, the local lesion was in the lower 9 centimeters of the rectum. Dissemination by systemic or portal circulation from the lower rectum must depend somewhat upon chance, however, since in 11 of the 23 patients with metastasis to the liver alone the local lesion was in the lower 6 centimeters of the rectum. In only 3 patients did blood borne metastasis take place without tumor deposits in the liver or lung. One occurred in a 68 year old woman complaining of convulsions 1 month previous to operation. A cerebral lesion was localized and at operation a nodule in the Rolandic region of the right cerebral cortex near the midline was found. Frozen section diagnosis of metastatic adenocarcinoma, probably of lower gastro-intestinal origin, was made. The following day postmortem examination disclosed 10 centimeters above the anus a fungating adenocarcinoma only 0.7 centimeters in diameter showing slight invasion of the muscularis. The 2 other cases involved bone. In 1 discrete nodules were present in lumbar and thoracic vertebrae. In the other tumor was present in a lumbar vertebra but local extension could not be ruled out. The 13 cases of bone metastasis included deserve some comment. In 2 metastases were present in the ribs and in 1 in the humerus. In the remainder the vertebrae were involved. In 2 of these the primary growth had been removed. In an additional 3 the thoracic vertebrae showed foci of growth. Five other tumors were adherent to and involved the sacrum or lower lumbar

TABLE VI—ALL CASES—INFLUENCE OF DEGREE OF INVASION ON VISCERAL METASTASIS

Resection deaths—45 cases	Number surgical specimens	Visceral metastasis on immediate autopsy	Percentage
Growth within musculature	17	1	6
Growth through musculature	21	2	10
Growth into adjacent organs	7	3	43
Resection survivals—26 cases	Number surgical specimens	Visceral metastasis in subsequent autopsy	Percentage
Growth within musculature	9	4	44
Growth through musculature	14	6	43
Growth into adjacent organs	3	2	67
Non-resection—99 cases	Autopsy specimens	Visceral metastasis at autopsy	Percentage
Growth within musculature	16	5	31
Growth through musculature	41	27	66
Growth into adjacent organs	22	20	48



Fig 4 Venule distended with mucinous secretion, debris, and cells of mucinous carcinoma. Tumor cells appear to be growing along the surface of the intima as well as beneath it. An accompanying arteriole is included. $\times 425$

assume to curability. Therefore we classified the lesions somewhat after the method of Lockhart-Mummery as (1) those remaining within the rectal musculature, (2) those perforating the muscular coat, and (3) those involving an adjacent organ by permeation. Each lesion was so classified and the visceral metastases occurring with it were noted. A summary of these when grouped according to treatment is shown in Table VI.

In the resection survival group, of the 12 cases with visceral metastasis found at autopsy, there had been local recurrence in 9, and involvement of an adjacent pelvic organ in 8. The 44 per cent organ metastasis of the growths within the muscularis as against the 43 per cent for those perforating the wall cannot be explained on the basis of the more malignant types falling into the former group, for on check-up such was not the case. The amount of perirectal tissue removed might be operative here since 7 of the 9 growths limited to the muscularis grossly were removed by posterior resection, and 3 of the 4 showing organ metastasis were removed by this method. This does not attain the significance one might be inclined to give it when one considers the 14 resection survivors with growths perforating the muscularis. Six of these showed visceral metastasis subsequently although only 2 were posterior resections. In the 8 without visceral metastasis,

2 were posterior resections. However, the fallacy of assuming, because there is no grossly visible extension of the growth through the bowel wall, that no such extension has taken place should be emphasized and the adoption of less radical procedures on this account must result inevitably in a certain number of recurrences and subsequent visceral metastases. The analysis by Dukes of 100 surgical specimens in which he finds as a rule that lymphatic spread does not play a part in dissemination until the growth has spread by contiguity through the rectal wall cannot explain the metastases following the removal of intramural growths in our series.

The location of the lesion in the rectum has been thought by some to condition the chances of visceral metastasis. Alleged variations in the abundance of lymphatics and veins in the anterior and posterior walls of the rectum has been assumed to account for supposed differences in the frequency of metastasis from this site. Unfortunately, the tumors in over half of our series are bulky and annular. The group of cases in which there is mention of anterior, posterior, or lateral position of the tumor is too small to merit any conclusions.

Regarding the effect of the tumor position in the longitudinal axis of the bowel upon visceral metastasis, certain obstacles are at hand. It is necessary first to select carcinomas of the same

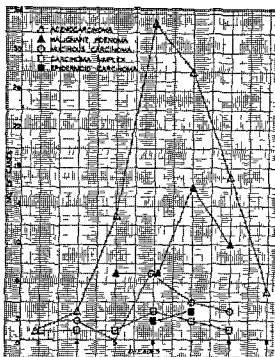


Chart 3 Age distribution

transly by the appearance of pertinent symptoms. Only such symptoms as rectal bleeding, progressive pain, or persistent change in bowel function have been utilized.

With due consideration of the shortcomings of the method, two features appear significant in Chart 2. In the period between 12 and 24 months all types show an increase in visceral metastases. After this period malignant adenomas show a surprising drop. The possibility of error in diagnosis between benign polyp and malignant adenoma cannot be entertained because these patients at death exhibited evidence of recurrent or spreading disease. Our only explanation for this phenomenon is the presence of tumors whose local exophytic tendency and obstructive effect far overshadow their power of vascular invasion. Morphologically we should expect such cases in the malignant adenoma group. In adenocarcinomas the tendency to visceral metastasis increases with the duration of the disease.

Pre-operative symptom duration merits only passing comment. Table V shows the average pre-admission symptom duration in patients after resection to be well below that in those in whom resection has not been done. Brindley found the symptom duration of 76 operable rectal

TABLE V — AVERAGE DURATION OF SYMPTOMS IN MONTHS ON ADMISSION

	Resected	ns	N	resected	s
	mos			mos	
Adenocarcinoma	10	4	17	3	
Malignant adenoma	12	9	17	6	
Mucinous carcinoma	7	4	10	7	
Carcinoma simplex	11	2	6	4	
Group average	10	6	16	4	

cancers to be 9.4 months. These averages have little application in determining operability because many of the patients with inoperable growths had a pre-admission duration of less than 11 months and some of those subjected to the resection had a pre-operative symptom duration of longer than 16 months. Four of the 6 patients with visceral metastasis who died following resection had a pre-operative symptom duration of less than 11 months; the average for the resection group. The pre-admission symptom duration has little utility in the determination of whether a patient with rectal carcinoma is operable.

The maximum age incidence of rectal cancer has been reported in the sixth decade (Hasden and Shedden and Miles 13). In our series 52 patients developed symptoms of rectal cancer in the sixth decade and 53 in the seventh. The sixth to eighth decades inclusive account for 80 per cent of the series. In Chart 3 the number of cases of each type is plotted against the decades into which they fall. It is seen that malignant adenoma reaches its maximum incidence in the seventh decade while adenocarcinoma, colloid carcinoma, and carcinoma simplex reach theirs a decade earlier. This slight support for the thesis that more malignant forms of carcinoma appear in the younger age groups is in agreement with other reports of a similar nature (Brindley, Fowler and Shedden).

The influence of sex upon the incidence or curability of rectal carcinoma is no different in this series than in others. Of the 170 patients 104 were males and 66 were females, a predominance frequently mentioned (Harding and Hankins, and Daland, Welch and Nathanson).

The size of the local lesion and its invasiveness are thought to have an effect upon the frequency of vascular metastases. It is often difficult to calculate accurately the size of an infiltrative growth in a tubular structure.

In some of the postmortem protocols one dimension of the tumor was omitted and the term annular was applied frequently to denote size. McVay has found that the size of the local growth apparently bears little relation to the extent of lymph node involvement, and we

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Growth into adjacent organs	42	20	48

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Fig. 4. Venule distended with mucinous secretion, debris, and cells of mucinous carcinoma. Tumor cells appear to be growing along the surface of the intima as well as beneath it. An accompanying arteriole is included. $\times 425$.

2 were posterior resections. However, the fallacy of assuming, because there is no grossly visible extension of the growth through the bowel wall, that no such extension has taken place should be emphasized and the adoption of less radical procedures on this account must result inevitably in a certain number of recurrences and subsequent visceral metastases. The analysis by Dukes of 100 surgical specimens in which he finds as a rule that lymphatic spread does not play a part in dissemination until the growth has spread by contiguity through the rectal wall cannot explain the metastases following the removal of intra-muscular growths in our series.

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Regarding the effect of the tumor position in the longitudinal axis of the bowel upon visceral metastasis, certain obstacles are at hand. It is necessary first to select carcinomas of the same



Fig 5. Tumor cells of adenocarcinoma growing in the lumen of a small artery within the bowel wall. This is a rare finding especially in surgical material. $\times 250$

kind and approximate duration. Many of the larger growths overlap any such arbitrary limits as 5, 10, or 15 centimeters above the anus. With these difficulties in mind we have chosen 33 adenocarcinomas with a maximum diameter of less than 5 centimeters located either in the first 5 centimeters of the rectum or between 10 and 15 centimeters above the anus. Twenty of these were located in the lower range, and 13 in the upper. Six of the lower growths and 9 of the upper growths had blood borne metastases. Results similar to these were found in larger less well controlled series. It appears, therefore from these limited data that there is a slightly greater tendency for the high rectal growths to yield visceral metastases. This apparent tendency does not extend to the sigmoid for Harding and Hankins have found metastasis to viscera more likely from rectal than sigmoidal growths.

The approximate agreement between the number of visceral metastases and the lymph node metastases for each type of growth is coincidence only. The fallacy of considering it valid in the individual case is apparent in the subsequent

TABLE VII—ASSOCIATION OF LYMPH NODES AND INTRAVASCULAR INVASIONS WITH VISCERAL METASTASES IN 100 CASES OF ADENOCARCINOMA 49 VISCERAL METASTASES

	Cases
Positive nodes and visceral metastases	32
Positive nodes and no visceral metastases	13
Total positive nodes	45
Visceral metastases and no positive nodes	17
No visceral metastases and no positive nodes	38
Total negative nodes	55
Total	100
Intravascular invasion and visceral metastases	49
Intravascular invasion and no visceral metastases	21
Total intravascular invasion	70
Visceral metastases and no intravascular invasion	0
No visceral metastases and no intravascular invasion	30
Total with no intravascular invasion	30
Total	100
	Percentage
Positive nodes associated with visceral metastases	71
Intravascular invasion associated with visceral metastases	70
Visceral metastases occurring without positive nodes	31
Visceral metastases occurring without intravascular invasion	0

tables which compare the percentage associations of neoplastic nodes and of local intravascular invasions with visceral metastases. Each case has been considered individually with regard to the lymph node metastases, and intravascular invasions present in the local lesion. These have been checked against the presence of coexistent distant visceral metastases. The lymph nodes listed as positive are those neoplastic nodes present in the surgical specimen or discovered subsequently in the abdomen at autopsy. The assumption is made that the surgeon might discover all intra abdominal neoplastic lymph nodes in the resection cases and that the 26 resection survivors without nodes at laparotomy did not develop them subsequently.

In Table VII we have divided the 100 cases of adenocarcinoma into those cases in which neoplastic nodes and visceral metastasis occurred together, into those in which one occurred and not the other, and into those in which neither occurred. The same has been done with growths showing local intravascular invasion. It appears that lymph nodes were positive in 45 cases and that in 32, or 71 per cent, of these visceral metastases were coexistent or developed subsequently.

TABLE VIII—ASSOCIATION OF LYMPH NODES AND INTRAVASCULAR INVASIONS WITH VISCERAL METASTASES IN 40 CASES OF MALIGNANT ADENOMA 9 VISCERAL METASTASES

	Cases
Positive nodes and visceral metastases	4
Positive nodes and no visceral metastases	3
Total positive nodes	7
Visceral metastases and no positive nodes	5
No visceral metastases and no positive nodes	28
Total negative nodes	33
Total	40
Intravascular invasion and visceral metastases	8
Intravascular invasion and no visceral metastases	4
Total intravascular invasions	12
Visceral metastases and no intravascular invasion	1
No visceral metastases and no intravascular invasion	27
Total with no intravascular invasion	28
Total	40
	Per cent
Positive nodes associated with visceral metastasis	57
Intravascular invasion associated with visceral metastasis	67
Visceral metastases occurring without positive nodes	15
Visceral metastases occurring without intravascular invasion	4

The nodes were negative in the 55 remaining cases, but in 17, or 31 per cent, of these, visceral metastases were found. Analyzed according to the invasion of vessels by tumor in the primary growth we find this to have occurred in 70 cases; and that in 49, or 70 per cent, of these, visceral metastases were present or developed subsequently. And in the 30 remaining which showed no intravascular growth locally, none had visceral metastases. A similar situation was found to exist in the 40 cases of malignant adenoma, and in the 165 cases comprising the entire adenoid group. Tables VIII and IX summarize these.

In only one instance did visceral metastases occur in the absence of local intravascular invasion. The groups of carcinoma simplex and mucinous carcinoma are too small for analysis separately and both have been included with the adenoid group.

The three foregoing tables make no correction for the varying methods of treatment. An attempt to do this has been made in Table X.

In general, the same trends are present as noted in Tables VII, VIII, and IX. The percentage showing visceral metastases associated with neoplastic lymph nodes is approximately the same as that in the case of local intravascular invasions and visceral metastases. It is interesting

TABLE IX—ASSOCIATION OF LYMPH NODES AND INTRAVASCULAR INVASIONS WITH VISCERAL METASTASES IN THE 165 CASES COMPRISING THE ENTIRE ADENOID GROUP. 68 VISCERAL METASTASES

	Cases
Positive nodes and visceral metastases	44
Positive nodes and no visceral metastases	23
Total positive nodes	67
Visceral metastases and no positive nodes	24
No visceral metastases and no positive nodes	74
Total negative nodes	98
Total	165
Intravascular invasion and visceral metastases	67
Intravascular invasion and no visceral metastases	33
Total intravascular invasion	100
Visceral metastases and no intravascular invasion	1
No visceral metastases and no intravascular invasion	64
Total with no intravascular invasion	65
Total	165
	Per cent
Positive nodes associated with visceral metastases	66
Intravascular invasion associated with visceral metastases	67
Visceral metastases occurring without positive nodes	24
Visceral metastases occurring without intravascular invasion	2

to note that these percentages increase as the duration of the disease increases. In the case of the lymph nodes going from 38 per cent in the acute resection deaths to 82 per cent in the non-resection cases, and in the case of intravascular growth from 38 per cent to 74 per cent. On the other hand, visceral metastases were present in 6 per cent of the cases of acute resection death which had negative lymph nodes, and in 46 per cent of the resection survivals with negative nodes. In contrast, visceral metastases were unheralded by local intravascular tumor in only one instance. In the 25 cases of resection survival, where prognosis attains some practical significance, the 11 cases of visceral metastasis all showed local vascular invasion. Only 5 of the 11 cases of visceral metastasis fell in the group of 12 cases showing neoplastic nodes.

It should be kept in mind that the foregoing discussion deals with the prediction of blood-borne metastases to viscera, and applies to individual and group prognosis only indirectly, since all deaths from rectal cancer are not concerned with visceral metastasis. Many result from massive local recurrence or postoperative complication.

The spread of rectal carcinoma through blood vascular channels is at least as important as

TABLE X—TOTAL GROUP 170 CASES—ASSOCIATION BETWEEN LYMPH NODES AND INTRA VASCULAR INVASION WITH VISCERAL METASTASES IN CASES DIVIDED INTO VARIOUS TREATMENT GROUPS

	Immediate post resection death		Resection survivals		Non resections		Total Percent
	Cases	Per cent	Cases	Per cent	Cases	Per cent	
Visceral metastases and positive nodes	5 in 13	38	5 in 13	38	36 in 44	82	66
Visceral metastases and negative nodes	2 in 32	6	6 in 13	46	16 in 55	29	24
Visceral metastases and intra vascular invasion	6 in 16	38	12 in 18	67	51 in 69	74	67
Visceral metastases and no intravascular invasion	0 in 20	0	0 in 8	0	7 in 31	23	7

Note: The 5 cases of epidermoid carcinoma are included. Twelve divided into metastases and both of these showed intravascular invasion. Because of overlapping of cases under different headings the total cases given in the table add to more than 170.

through the lymphatic route. Evidence of this vascular spread is usually available in the primary growth. The relatively large number of cases (33 per cent) with tumor growth within vessels locally and with no coexistent visceral metastasis detracts from the value of this factor in a positive sense. It serves to emphasize a fact determined experimentally by Warren and Gates that only a small proportion of tumor cells entering the circulation survive and grow in distant foci. Likewise this circumstance in rectal carcinoma is similar to that found by Clute and Warren in carcinomas and potentially malignant adenomas of the thyroid where the local intravascular invasions are many but the distant metastases relatively few. Nevertheless as far as the prediction of visceral metastases in rectal carcinoma from the local growth and nodes is concerned, the presence of intravascular tumor means as much from the prognostic standpoint as neoplastic nodes and their absence means much more.

Detailed methods of statistical analysis have been applied to the data concerning lymph node involvement and visceral metastases though omitted here to conserve space. The conclusions may be regarded as sound so far as the primary data warrant them.

SUMMARY AND CONCLUSIONS

1 The tendency of rectal carcinoma to metastasize via the blood stream varies in general with the degree of differentiation. Malignant adenoma produced visceral metastases in 23 per cent of our cases, adenocarcinoma in 49 per cent and carcinoma simplex in 56 per cent.

2 Mucinous carcinoma has a marked tendency to metastasize by way of the lymphatics.

3 In general the longer the duration of rectal carcinoma the greater are the number of visceral metastases.

4 Metastasis of rectal carcinoma to bone is not rare. 5 per cent in this series.

5 The more the primary growth penetrates the bowel wall the greater are the chances of blood borne metastasis.

6 The reliability of prognosis of visceral metastases by observation of local intravascular invasion and to a less extent by lymph node metastasis, increases with the duration of the disease.

7 Forty-one per cent of the cases showed visceral metastases.

8 Sixty-one per cent of the cases showed local intravascular invasion.

9 Sixty-seven per cent of those with local intravascular invasion showed visceral metastases closely paralleling the 66 per cent of visceral metastases with positive lymph nodes.

10 Only 1 case of the 70 showing visceral metastases failed to show local intravascular invasion, whereas 24 cases (34 per cent) of these failed to show positive lymph nodes, or, expressed in a different way, 24 per cent of the cases with negative nodes had visceral metastases.

11 Sections of the primary growth in rectal carcinoma should be scrutinized carefully for invasion of capillaries or veins by tumor, because intravascular tumor invasion frequently means visceral metastases and its absence, provided at least three sections from different parts of the growth are examined, nearly always rules out visceral metastasis. Its efficiency in predicting visceral or bone metastasis outranks that of neoplastic lymph nodes.

We are indebted to the members of the staffs of the hospitals mentioned for use of the cases and for helpful suggestions particularly Drs. Ernest M. Daland, Frank H. Lahey and Leland S. McKinnick. We thank Dr. Tracy B. Mallory for data on seven surgical specimens from the laboratory of the Massachusetts General Hospital.

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VITAMIN OILS IN THE TREATMENT OF BURNS

An Experimental Study

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THE therapeutic value of fish liver oils and of vitamins in the healing of burns and other wounds has been discussed frequently in recent medical literature. Most observers are enthusiastic over the results obtained, but all do not agree as to the factors responsible for them. This study was undertaken to obtain some knowledge of the comparative values of several oils and other commonly used agents in the healing of burns.

Stimulation of tissue growth has been noted following the administration of cod liver oil and of vitamin preparations by various routes. Wuttig, in 1905, produced considerable endothelial proliferations in the liver by injecting cod liver oil into the mesenteric veins of rabbits whereas olive oil was inert. Bond applied irradiated ergosterol dissolved to saturation in liquid petrolatum as a dressing for ulcers and granulating wounds. He believed that it reduced infection, promoted healthy granulations and stimulated epithelization, possibly due to a further continued irradiation effect on the wound tissues after the primary irradiation of the sterol by the ultraviolet rays from the mercury vapor lamp had ceased. Loehr has used cod liver oil dressings extensively in the treatment of burns and other wounds. He obtained excellent results in a large series of patients with second and third degree burns. Cod liver oil was mixed with inert materials to form a paste, which was applied freely to the burned areas. If these were on the extremities, plaster casts were applied over the dressings. The dressings were changed as infrequently as possible but could be removed painlessly. He states that cod liver oil is self sterilizing and found that it diminished the

incidence of infection of burns and controlled secondary infection when present. The wounds were rapidly cleansed and epithelization was stimulated to a degree not seen in any other form of treatment. Skin grafting was not found necessary in wounds treated by this method. Loehr further states that the treatment did not prevent early fatalities from burns more than other forms of therapy, but the number of late fatalities, due to secondary infections, was markedly reduced more so than with tannic acid. He attributes the effect of cod liver oil therapy to the action of vitamins A and D on the tissues of the wound. Its chief disadvantage is the odor.

Other observers have been favorably impressed by results obtained with cod liver oil dressings applied to burns and wounds. Steel reports that indolent ulcers were rapidly healed by it. Marked relief of pain followed its application, more so than with other dressings (11, 12). Skin wounds in guinea pigs (3) healed better after application of cod liver oil ointment than after vitamin free ointment. Vitamin A ointments have been used by Horn and Sandor and by Sandor, who believe it inhibits infection and stimulates healing. Lauber and Rocholl found that small and medium amounts of vitamin A added to a cholesterol base accelerated the healing of experimental wounds by 50 per cent but larger amounts inhibited recovery as did other vitamins with various bases.

The influence of vitamin deficiencies on wound healing and the effect of the administration of various vitamins by mouth has been studied. Lauber produced wounds on the backs of rats and noted the time of healing while on an ordinary diet. Addition to the diet of 4 units daily of vitamin A shortened the healing time by one half. Large quantities had no effect and massive doses (40,000 units

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Fig 1 Twelve day old control burn This burn has not been treated



Fig 2 Twelve day old burn treated with 5 per cent fresh tannic acid solution



Fig 3 Twelve day old burn treated with ointment No 5, high vitamin A to D ratio

daily) more than doubled the healing period. He found that administration of vitamins B and D had no effect on healing time, but that avitaminosis definitely retarded it. In treating severe and infected burns Franzetti administered orally 20 to 30 drops of a solution containing 12,000 units per cubic centimeter each of vitamins A and D. He applied camphor in oil containing vitamins A and D to the burned areas. Under this form of therapy he observed that the local infections responded well and the general intoxication, edema, fever, and albuminuria rapidly diminished.

Davson does not believe vitamin A to be the responsible agent for tissue regeneration. He injected subcutaneously cod liver oil and halibut liver oil into the ears of rabbits and at a later date made histological sections. Although he states that vitamin A is 100 times greater in amount in halibut liver oil than in cod liver oil, both preparations produced the same degree of tissue response, a marked stimulation of phagocytes, fibroblasts, and young capillaries. Liquid paraffin and olive oil proved relatively inert when employed in similar experiments.

METHOD

Pigs and rabbits were employed in the experiments here presented. The former were used because their size and the thickness of the skin permits the production of sufficiently large lesions for more accurate study. The reaction of the skin of pigs to heat appears similar to that of human skin, except that

vesicles do not form. Burns were produced in shaved areas of the back with the animals under general anesthesia. Lesions were produced by the use of an electrocautery applied to a given area at a constant temperature for a definite period of time. By careful regulation of the degree of heat and the time of application an attempt was made to produce a number of wounds of the same depth in a given experiment, so that a more accurate evaluation of the effects of various therapeutic agents could be made. On a given date a number of uniformly deep lesions were produced and each treated with a different therapeutic agent, generally one lesion being left untreated as a control.

On a later date another experiment was started by producing a series of burns which were all of equal depth but all deeper than those of the previous experiment. Each of these likewise was treated with a different therapeutic agent. Thus the burns in each given experiment were of uniform depth although the depths of lesions varied in different experiments. Care was taken to use areas of skin of similar location and thickness. Applications of the ointments were made twice daily to assure the constant presence of the medication. The size of the burns was measured when produced, and subsequent measurements were made to determine the rate of healing. The character of the crust and the presence or absence of secondary infection was noted. After complete healing biopsy specimens of the entire epidermis were studied his-

tologically to determine the amount, thickness, and type of epithelium and the amount and degree of fibrosis and hyalinization of the scars. Adequate and uniform diets were fed throughout the experiments.

Each therapeutic ointment consisted of 6-1/2 per cent by weight of the specific oil compounded with a base consisting of yellow bees wax, 15 per cent, hydrous wool fat, 12.5 per cent, and spermaceti, 10 per cent. The oils employed and their identification numbers are as follows:

- 1 Olive oil free of vitamins
- 2 Cod liver oil containing 1800 units of vitamin A and 175 units of vitamin D per gram
- 3 Irradiated ergosterol in oil containing 1 million units of vitamin D per gram
- 4 Fish liver oil containing 45,000 units of vitamin A and 75,000 units of vitamin D per gram
- 5 Fish liver oil containing 380,000 units of vitamin A and 2,000 units of vitamin D per gram

Five per cent tannic acid solution was applied to other lesions, and control lesions were left untreated.

VITAMIN CONTENT OF THERAPEUTIC OINTMENTS

Ointment number	Units per gram of ointment	
	Vitamin A	Vitamin D
1	0	0
2	1.5	100
3	0	625,000
4	28.5	46,875
5	37,500	50

RESULTS

From Table I a graph (Fig. 6) was made showing the average size of the burns treated with each therapeutic agent and the average number of days required for complete healing to occur. A review of this graph permits certain conclusions. The application of fresh 5 per cent tannic acid solution did not appreciably diminish the time required for complete healing of burns in pigs as compared with similar lesions untreated. Lesions treated with a vitamin free olive oil ointment healed in approximately the same length of time as the control burns but averaged about 25 per

TABLE I — RESULTS OBTAINED IN TREATMENT OF BURNS IN PIGS

Experiment number	Treatment used	Size of burn sq. cm.	Number of days for complete healing
1	No. 1	15	29
	2	19	29
	3	25	28
	4	24	27
	5	26	28
2	No. 1	13	22
	2	20	16
	3	28	18
	4	28	15
	5	28	16
3	Tannic acid	24	22
	No. 1	121	31
	2	143	8
	3	94	14
	4	114	15
4	No. 1	77	22
	No. 1	94	38
	3	105	24
	4	90	4
	5	90	34
5	Tannic acid	60	34
	None	58	34
	No. 1	90	38
	3	98	28
	4	128	24
6	5	150	38
	No. 3	94	6
	4	98	2
	5	90	17
	Tannic acid	50	45
7	None	31	43
	No. 1	20	28
	3	5	29
	5	161	30
	Tannic acid	8	8
8	None	68	3
	No. 1	72	30
	2	68	7
	3	94	22
	4	67	15
9	5	90	7
	Tannic acid	50	27
	No. 1	50	27
	2	50	27
	3	50	27



Fig 4 Photomicrograph of scar of healed burn treated with 5 per cent fresh tannic acid solution

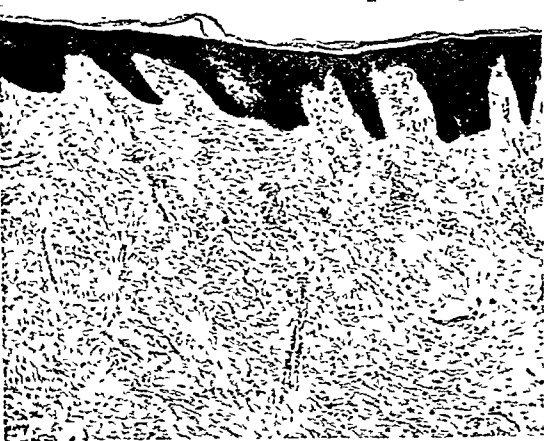


Fig 5 Photomicrograph of scar of healed burn treated with ointment No 4.

cent larger in area. The average size of burns to which cod liver oil ointment was applied was equal to that of the controls but the period of healing was more than 25 per cent shorter than that of the controls or of tannic acid treated lesions. The three high vitamin ointments, No 3 very high in vitamin D, No 4 with a low vitamin A to vitamin D ratio, and No 5 with a high vitamin A to vitamin D ratio, were applied to burns averaging nearly 50 per cent larger in size than the controls or those treated with tannic acid or standardized cod liver oil ointment. The time of healing of lesions treated with these high vitamin ointments was approximately the same as that required to heal the smaller lesions treated with cod liver oil ointment. Thus lesions 50 per cent larger than the controls were completely epithelized in approximately three-quarters of the time required to produce the same degree of repair in the controls or in the lesions treated with tannic acid. The results of the three high vitamin ointments were so nearly alike that none can be considered superior to any other in the stimulation of wound healing. As vitamin A was entirely absent from ointment No 3 it seems fair to assume that this vitamin is not the important factor in wound healing. However, high concentrations of vitamin A did not retard healing in these experiments. In cod liver oil ointment in

which the concentration of both vitamins A and D was comparatively low healing was definitely stimulated but not to the same degree as was noted with the use of ointments containing a high concentration of either A or D.

Table II shows the results obtained in the treatment of burns on rabbits. Here the results compared quite favorably with those

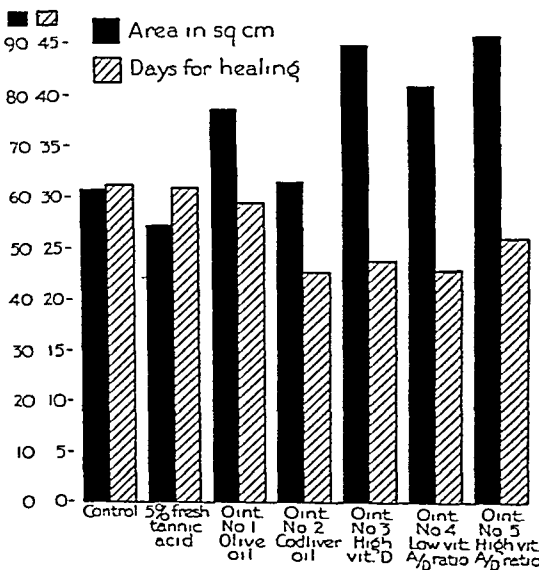


Fig 6 Graph showing average size of burned areas and average number of days required for complete healing with each therapeutic agent

TABLE II—RESULTS OBTAINED IN TREATMENT OF BURNS IN RABBITS

Experiment number	Therapeutic agent used	Size of burn sq. cm.	Number of days for complete recovery
9	No. 1	40	59
	2	45	45
	4	45	33
10	No. 1	14	30
	1	23	32
	1	24	31
	4	22	1
11	No. 1	23	33
	1	14	55
	1	14	33
	3	6	8
	5	18	36
	5	30	36
	Tannic acid	4	36
	Tannic acid	13	33
	None	11	33
	No. 4	0	33
12	No. 1	16	32
	1	14	3
	1	16	39
	3	8	16
	5	13	34
	5	18	3
	5	18	34
	Tannic acid	1	34
	Tannic acid	9	3
	Tannic acid	0	32
	None	1	32
	None	9	3
	N	9	3

obtained from pigs except that the degree of acceleration of healing was perhaps less marked. Fifteen rabbits had burns treated with ointment No. 3 which was very high in vitamin D. All but two died in less than a week, suggesting a very toxic effect of this ointment. The two which lived had sustained very small lesions.

Careful histological studies were made of all lesions. An attempt was made to compare the thickness and type of epithelium and the amount and degree of fibrosis and hyaliniza-

tion. The epithelium everywhere was fairly well developed. There were well developed connective tissue changes of moderate hyaline and fibrous character, with no areas of keloid density. The microscopic variations were so slight that they could well be accounted for by differences in age, size and sex of the animal and variations in thickness of the skin in different parts of the body. It was concluded that there were no characteristic microscopic differences in the scars of lesions treated by the various agents (Figs. 4 and 5).

No attempt has been made in this study to compare the systemic effects of burns under the various treatments employed. The pigs had no obvious general effects from the burns, as the lesions, in comparison to their total skin surface area were small. However in rabbits the very high mortality when burns were treated with high vitamin D ointment was striking.

SUMMARY

Controlled burns were produced upon pigs and rabbits and were treated with ointments containing varying amounts of vitamin A and vitamin D. The time and character of local wound healing was determined and compared with untreated controls and burns treated with tannic acid.

Burns treated with 5 per cent fresh tannic acid solution healed in the same length of time as untreated controls of similar average size.

The application of vitamin free olive oil ointment to slightly larger burns was followed by complete healing in the same length of time as the controls.

Cod liver oil ointment shortened by 23 per cent the healing period of burns equal in size to the controls.

Burns which averaged 50 per cent larger than the controls were treated with three high vitamin ointments. No. 3 containing no vitamin A but very high in vitamin D, No. 4 having a low vitamin A to vitamin D ratio and No. 5 with a high vitamin A to vitamin D ratio. The time of healing was approximately 25 per cent shorter than in the smaller control lesions and those treated with tannic acid. It was no longer than in the smaller lesions treated with cod liver oil ointment of low vitamin content. The response to the various high

vitamin ointments employed was approximately the same

Histological studies of the scars of all healed burns revealed no characteristic difference for the various therapeutic agents employed

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THE RELATION OF CATGUT SENSITIVITY TO WOUND HEALING

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IN a previous article (6) entitled "Intrinsic Factors Altering the Absorption of Catgut" evidence was presented which seemed to indicate that the sensitivity of an individual to one or more of the specific constituents of this suture material was one of the causes of its premature absorption.

The possibility of a relationship between sensitivity to suture material and post-operative wound complications has been appreciated by many observers. Gratia and Gilson were impressed with the frequency with which postoperative adhesions and even intestinal obstruction occurred along the line of catgut suture in patients having been operated on previously or to whom serum or protein therapy had been given. They came to the conclusion that these complications were manifestations of a localized allergic reaction to catgut which was due to the introduction of this antigen in a previously sensitized individual.

They first sensitized three groups of guinea pigs, one to sheep serum, one to horse serum and one to both sera, while another group served as controls. They then introduced a suspension of powdered catgut into the abdominal cavity of these animals. After 8 days the sensitized guinea pigs showed an intensely hemorrhagic inflammatory intraperitoneal reaction with adhesions of the intestinal loops, and some of those not immediately sacrificed developed intestinal obstruction. It was found that the greatest reaction occurred in those guinea pigs which had been sensitized to sheep serum, a less intense reaction occurred in the others, while none occurred in the controls. They also sensitized three groups of rabbits to catgut, horse, and sheep sera respectively, and then introduced powdered catgut, desiccated horse serum, and desiccated sheep

serum respectively into the peritoneal cavities as well as into a group of non sensitized rabbits. The greatest reaction was found to have occurred in the animals sensitized to catgut and to a less degree in those sensitized to horse and sheep sera, but it was not stated what reactions occurred when animals previously sensitized to sheep serum or horse serum were tested with catgut. These reactions were said to be similar to the necrotic nodule produced in the subcutaneous tissue by repeated inoculations of antigen as described by Arthus. Efforts were made to desensitize the animals by the introduction of various substances, but this was entirely unsuccessful. One thing was demonstrated, however, that if catgut was immersed for a time in anti sheep rabbits serum, it failed to produce the reactions in the sensitized animals.

In an attempt to disprove the theories of Gratia and Gilson, Frugoni in a series of experiments was unable to find precipitins in the sera of rabbits which were supposedly sensitized to catgut and failed to produce anaphylactic shock in a group of guinea pigs. He also introduced catgut into the peritoneal cavities of another group of animals and after 3 months introduced more. Many of the animals developed no adhesions and those reactions which did occur were thought to have resulted from foreign body reaction or from infection. No skin tests were made to indicate whether or not sensitivity had been produced.

Catgut used in most parts of Europe is chemically sterilized and frequently hardened with formaldehyde, resulting in an almost non absorbable material. Frugoni's negative results may have been due to the use of this type of catgut.

Marchesani was not entirely successful in demonstrating the relationship of the specificity between catgut and sheep serum. How

ever, in animals which were sensitized with catgut extract, the introduction of catgut beneath the skin caused a marked reaction. This was studied microscopically and consisted of hyperemia, edema, increased leucocytic response, and even local necrosis was occasionally produced. Allergic reactions were also demonstrated in animals sensitized to catgut by introduction of catgut extract in the conjunctival sac. No evidence of either type of reaction could be seen in the non-sensitized animals.

Babcock pointed out that faulty wound healing is frequently observed following thyroidectomy where catgut is used. He suggested that the edema, serosanguineous discharge, and slight separation of wound margins was due to sensitivity to the catgut, but he did not demonstrate sensitivity in these cases. However, when he substituted silk these reactions were entirely eliminated in 80 consecutive thyroidectomies. Babcock's method of testing normal individuals for sensitivity to catgut is open to question, for he found reactions in all of the 120 individuals in which he buried small strands of catgut beneath the skin.

Hinton suggested the possibility of a relationship between catgut sensitivity and wound dehiscence as well as postoperative incisional hernia. He considered this possibility in 3 of 19 cases of wound disruption in which there seemed to be no other adequate cause. He did not demonstrate sensitivity by appropriate skin reactions in these cases but in a group of 112 normal patients without previous contact with catgut he found 9 which gave a positive reaction to the intradermal injection of an extract of fresh sheep intestine. He assumed, therefore, that a certain percentage of all operative patients are sensitive to catgut.

Another interesting but rather speculative observation was a case reported by Tripp. The patient suffered from asthma following a second operation and the symptoms subsided after it was assumed that the catgut had been absorbed. Tripp believed that the individual had been sensitized by the suture material of her previous operation but no skin test confirmed this impression.

TABLE I — REACTIONS OF SENSITIZED ANIMALS SUTURED WITH PLAIN CATGUT

Pig No	Route of sensitization	Skin reaction	Laparotomy	Wound healing
64	Intraperitoneal injection and laparotomy (pl)	+	Plain	Normal
597	Intraperitoneal injection (pl)	+	Plain	Normal
67	Intraperitoneal injection (pl)	+	Plain	Normal
575	Intradermal injection (pl)	+	Plain	Normal
578	Intracardiac injection (pl)	+	Plain	Normal
78	Intraperitoneal injection and subcutaneous suture (pl)	+	Plain	Normal
551*	Subcutaneous suture (ch)	+	Plain	Normal
105	Subcutaneous suture (pl)	+	Plain	Normal
109	Subcutaneous suture (pl)	+	Plain	Normal
69	Intraperitoneal injection and laparotomy (pl)	+	Plain	Abnormal
70	Intraperitoneal injection and laparotomy (pl)	+	Plain	Abnormal
74	Intraperitoneal injection and laparotomy (pl)	+	Plain	Abnormal
107	Subcutaneous suture (pl)	+	Plain	Abnormal
108	Subcutaneous suture (pl)	+	Plain	Abnormal
118	Subcutaneous suture (pl)	+	Plain	Abnormal
616	Subcutaneous suture (pl)	—	Plain	Abnormal
555	Subcutaneous suture (pl)	+	Plain	Abnormal
581	Intraperitoneal injection (pl)	+	Plain	Abnormal
583	Subcutaneous suture (pl)	Not tested	Plain	8th day Disrupted
104	Subcutaneous suture (pl)	+	Plain	4th day Disrupted
106	Subcutaneous suture (pl)	+	Plain	4th day Disrupted
614	Subcutaneous suture (pl)	+	Plain	4th day Disrupted
613	Subcutaneous suture (pl)	+	Plain	7th day Disrupted
584	Laparotomy (pl)	+	Plain	4th day Disrupted
560	Intraperitoneal injection (pl)	—	Plain	3rd day Disrupted
592	Intraperitoneal injection and subcutaneous suture (pl)	—	Plain	1st day Disrupted
595	Intraperitoneal injection and subcutaneous suture (pl)	—	Plain	2nd day Disrupted
598	Intraperitoneal injection and subcutaneous suture (pl)	+	Plain	2nd day Disrupted

*No. 551 was sensitized to chronic catgut and laparotomy performed with plain catgut.

Jenkins has also considered the possibility of catgut sensitivity as a cause of premature absorption in a discussion of the whole problem of wound disruption.

In a previous clinical and experimental report (6), a study of wound healing was made

TABLE II — REACTION OF SENSITIZED ANIMALS
SUTURED WITH CHROMIC CATGUT

Pig No	Route of sensitization	Skin reaction	Laparotomy	Wound healing
79	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	Normal
591	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	Normal
554	Subcutaneous suture (ch)	+	Chromic	Normal
579	Subcutaneous suture (ch)	+	Chromic	Normal
580	Subcutaneous suture (ch)	+	Chromic	Normal
582	Intraperitoneal injection (ch)	—	Chromic	Normal
583	Intraperitoneal injection (ch)	+	Chromic	Normal
75	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	Abnormal
103	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	Abnormal
554	Subcutaneous suture (ch)	+	Chromic	Abnormal
564	Intraperitoneal injection (ch)	+	Chromic	Abnormal
66	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	3rd day Disrupted
594	Intraperitoneal injection and subcutaneous suture (ch)	+	Chromic	6th day Disrupted
556	Subcutaneous suture (ch)	+	Chromic	2nd day Disrupted
582*	Subcutaneous suture (pl)	+	Chromic	3rd day Disrupted
585	Laparotomy (ch)	—	Chromic	4th day Disrupted

*No. 582 was sensitized to plain catgut and the laparotomy performed with chromic catgut.

in a small group of sensitized and non sensitized guinea pigs. It was found that 6 of the 19 sensitized animals disrupted their laparotomy wounds while this did not occur in the 6 control animals. In the present report this study has been continued on a larger scale to include 84 guinea pigs. Of these 28 were sensitized to plain catgut, 16 were sensitized to chromic catgut, 8 to chromic acid while 20 were used as controls. The 6 remaining died of intercurrent infection.

DETAILS OF EXPERIMENTS

Sensitization to plain catgut. The first group of 28 animals was sensitized to plain catgut by several methods and by a combination of these methods (Table I). Eight animals received 0.1 gram of powdered catgut introduced into the peritoneal cavity through a 1 centimeter incision which was closed with 1 bolt suture of the same suture material. These animals were tested at 2 week intervals with

TABLE III — REACTION OF ANIMALS SENSITIZED
TO CHROMIC ACID AND SUTURED WITH
CHROMIC CATGUT

Pig No	Route of sensitization	Skin reaction	Laparotomy	Wound healing
111	Subcutaneous injection (ch a)	+	Chromic	Normal
605	Subcutaneous injection (ch a)	+	Chromic	Normal
608	Subcutaneous injection (ch a)	+	Chromic	Normal
113	Subcutaneous injection (ch a)	+	Chromic	Abnormal
604	Subcutaneous injection (ch a)	+	Chromic	Abnormal
607	Subcutaneous injection and laparotomy (ch a ch b p l)	+	Chromic	Abnormal
60	Subcutaneous injection (ch a)	+	Chromic	5th day Disrupted
609	Subcutaneous injection (ch a)	+	Chromic	7th day Disrupted

TABLE IV — RESULTS OF LAPAROTOMIES PER-
FORMED ON SENSITIZED AND NON SENSITIZED ANIMALS

	Wound healing after laparotomy		
	Normal	Abnormal	Disrupted
28 animals sensitized with plain catgut	9	9	10
16 animals sensitized with chromic catgut	7	4	5
8 animals sensitized with chromic acid	3	3	2
13 control animals with plain laparotomy	3	0	0
13 control animals with chromic laparotomy	1	8	0

an intradermal injection of catgut extract but after 1 month as there was no evidence that they were sensitive, 4 of them then received an additional 2 strands of catgut about 2 centimeters long introduced beneath the prepared skin of the back while the remaining 4 had a laparotomy incision closed with 3 bolt sutures of the same suture material. These guinea pigs were tested for sensitivity at 2 week intervals and at the end of 3 months all showed a positive skin reaction.

Four animals received an intraperitoneal injection of 2 cubic centimeters of the plain catgut extract and these were skin tested every 2 weeks. Sensitivity was manifest after 1 month. In 13 animals 3 double strands of catgut about 4 centimeters long were introduced subcutaneously. After a 2 month interval they gave a positive response to an intradermal test. The 3 remaining animals

TABLE V—INTRADERMAL TESTS TO SUTURE MATERIAL

	Number patients tested	Number patients giving positive reaction to one or more solutions	Number reactions obtained to testing solutions*								
			Plain catgut			Chromic catgut			Chromic acid		
			+	±	Negative	+	±	Negative	+	±	Negative
Patients with disruption following operation											
Allergic patients	5	5 (100%)	3	0	2	2	2	1	2	0	3
Non-allergic patients	25	13 (52%)	6	3	16	7	4	14	7	4	14
Patients with a history of previous operation											
Allergic patients	33	5 (15.1%)	3	3	27	1	2	30	3	1	29
Non-allergic patients	42	4 (9.5%)	4	1	37	1	2	39	0	6	36
Patients without history of previous operation											
Allergic patients	98	17 (17.3%)	11	6	81	3	3	92	6	6	86
Non-allergic patients	129	3 (2.3%)	2	4	123	2	4	123	1	5	123

*Control (saline)—Negative reactions

were sensitized as follows: 1 by laparotomy using 3 sutures of plain catgut to close the incision; 1 by 3 intradermal injections of 0.1 cubic centimeter of plain catgut extract, and 1 by 1 intracardiac injection of 0.5 cubic centimeter of the same material which resulted in a positive skin reaction after 19 days.

Sensitization to chromic catgut. Sixteen guinea pigs survived sensitization to chromic catgut (Table II). Of these 6 were sensitized by the subcutaneous suture method, 6 were sensitized by a combination of intraperitoneal injection of powdered catgut and subcutaneous suture, 3 by intraperitoneal injection of 2 cubic centimeters of chromic catgut extract, and 1 by laparotomy, chromic catgut being used to close the incision.

It was found that the animals receiving the powdered catgut intraperitoneally were not sensitive after more than 5 weeks had elapsed and they received an additional 2 strands of catgut subcutaneously. After another month elapsed they were then found to be sensitive by the skin test.

The average time required to sensitize the animals by repeated injections of extract intraperitoneally was 1½ months. The average time for sensitization by the subcutaneous suture method was 3 weeks, although 2 animals gave a positive skin reaction at the end of 17 days, which was the shortest time recorded.

Sensitization to chromic acid. Believing that the chrome radical might prove to be of inter-

est in this connection, a group of 8 guinea pigs received 2 cubic centimeters of a 1 to 10,000 solution of chromic acid subcutaneously. It was found that the animals required 2 or 3 injections at 5 week intervals to produce evidence of sensitivity as determined by intradermal skin tests of the same material (Table III).

Control group. Twenty-six guinea pigs reserved for the control group were skin tested for sensitivity to the material to be used. There were 23 negative and 3 gave a doubtful reaction.

Evidence of sensitivity. As has been indicated in the previous paragraphs animals were skin tested for evidence of their sensitivity. This was done by the injection of a dilute solution of catgut extract or chromic acid into the shaved skin of the abdominal wall. A positive reaction consisted of redness, flare, and wheal. A doubtful reaction consisted of a mild area of redness, while a negative reaction showed no apparent response of any type.

Preparation of catgut extract and chromic acid solution. The catgut extract was prepared by grinding a large amount of the dried material to a powder. This was sterilized in an oven for 1 hour as described by Rappaport, and 5 grams were extracted for 24 hours in an agitator, in 100 cubic centimeters of one-hundredth normal sodium hydroxide. The suspension was filtered through a Chamberlain filter and then through a Berkefeldt filter. Nitrogen determinations were made by the

TABLE VI—SUMMARY OF 30 CASES OF WOUND DISRUPTION

Unit history number	Operation	History of allergy	Previous operation	Day of disruption	Infection	Other factors contributing to disruption	Appearance of catgut suture at disruption	Flain	Intradermal tests		
									Chromic	Chromic acid	Salt
312533	Cholecystectomy	Eczema asthma	Yes	8th	Yes	Brachial asthma disturbance	Unknown	o	o	+	o
477250	Gastro-enterostomy	None	None	6th	None	Cough bronchopneumonia	No evidence of chromic catgut found	o	±	+	o
437983	Appendectomy	None	None	6th	Hemo and non hemo B acid lactics and Strep non-hemo	Abdominal pain	Chromic catgut knots seen	+	+	+	o
447433	Cholecystectomy	None	None	9th	Hemo Staph aureus	Cough bronchopneumonia	Unknown	o	o	±	o
445403	Partial gastrectomy	None	Yes	6 12 and 6p	B pyocyaneus	Cough pulmonary tuberculosis bronchopneumonia	Unknown	o	+	±	o
497307	Cholecystectomy	None	None	21th	Yes	None	Unknown	o	±	±	o
404408	Abdomino-perineal proctectomy colostomy	None	None	8th	Yes	None	No evidence of chromic catgut found	+	+	+	o
498605	Cholecystectomy	Asthma	None	7th	None	None	Unknown	+	+	o	o
459628	Duodenal resection	None	None	6th	Yes	Slight distention	Unknown	±	o	o	o
501400	Cholecystectomy	None	Yes	7th	None	Pneumonia cough	Unknown	+	+	o	o
508828	Cholecystectomy	None	None	4th	Yes	Pneumonia cough	No evidence of chromic catgut found	+	o	o	o
449060	Partial gastrectomy	None	None	10th	Yes	Bronchitis cough	Unknown	+	o	o	o
345977	Jejunostomy	None	None	5th	B. coli, hemo and non hemo Staph albus	Slight distention	Unknown	+	±	±	o
447020	Partial colectomy	None	Yes	8th	Yes	Cough	Frayed pieces of catgut seen	o	o	o	o
506762	Abdomino-peritoneal resection	None	Yes	10th	Yes	Distention	No evidence of chromic catgut found	o	o	o	o
350923	Partial colectomy	None	None	6th	Staph aureus and albus	Distention	No evidence of chromic catgut found	±	o	o	o
335605	Cholecystectomy	Asthma	None	8th	Strep hemo Staph albus	Hiccoughs bronchopneumonia	Unknown	o	+	+	o
435970	Partial colectomy	None	Yes	4th	Strep hemo	None	Unknown	o	+	+	o
377487	Cholecystectomy	None	None	8th	Yes	Vomiting stitch abscesses	Unknown	o	o	o	o
353157	Cecostomy	None	Yes	8th	Yes	Vomiting cough	Unknown	o	o	o	o
354658	Partial gastrectomy	None	Yes	5th	None	Vomiting hic coughs	Unknown	o	o	o	o
372630	Herniotomy	None	None	5th	None	Cough pneumonia	No evidence of chromic catgut found	o	o	o	o
379346	Perforated gastric ulcer	None	Yes	10th	Yes	Bronchopneumonia stitch abscess	Unknown	o	o	o	o

TABLE VI—SUMMARY OF 30 CASES OF WOUND DISRUPTION—Continued

Unit history number	Operation	History of allergy	Previous operation	Day of disruption	Infection	Other factors contributing to disruption	Appearance of catgut suture at disruption	Plain	Intradermal tests		
									Chromic	Chromic acid	Saline
243065	Hysterectomy	None	None	7th	Yes	Acute intestinal obstruction	Chromic catgut had not been absorbed	o	o	o	o
2873-4	Pyloroplasty	Hay-fever	Yes	9th	Yes	Cough, distention	Chromic catgut had been absorbed	+	±	o	o
394801	Partial colectomy	None	None	4th	Yes	Hiccoughs	Fragments of chromic catgut found	o	±	+	o
359103	Exploratory laparotomy	None	Yes	5th	B hemo subtilis and Staph albus	Cough, upper respiratory infection	Chromic catgut had been absorbed	o	+	+	o
461577	Gastrorrhaphy	Eczema	None	5th	Yes	Cough	One or two chromic sutures found	+	±	o	o
365634	Cholecystectomy	None	None	8th	B subtilis	Cough	No plain suture found	o	o	+	o
251856	Exploratory celiotomy	None	Yes	5th	None	Cough	Unknown	±	+	o	o

micro Kjeldahl method. What portion of this nitrogen represented dissolved protein was not determined. In the case of the chromic catgut, the result was 0.14 milligrams of total nitrogen per cubic centimeter and of the plain catgut the result was 0.13 milligrams per cubic centimeter. These extracts were diluted to 100 cubic centimeters with saline for the final concentrations. Cultures were made of the solutions and no growth was obtained.

Chromic acid solution was also prepared in saline in a concentration of 1:10,000 and autoclaved before using.

Laparotomy procedure. After a positive skin test had been obtained, laparotomies were performed on all animals in the following manner. The animal was anesthetized with ether, the abdomen was shaved, and the skin was prepared with iodine and alcohol. A paramedian incision was made approximately 2.5 centimeters in length. This was extended down to the muscle which was usually separated by blunt dissection. The peritoneum was incised thus exposing the viscera. Then those sensitized to plain catgut were sutured with No. 00 plain catgut taken through all the layers of the abdominal wall. Those sensitized to chromic catgut were similarly sutured with chromic catgut, except No. 551 which was sensitized to chromic catgut and had a laparotomy performed with plain catgut and animal No. 582 which was sensitized to plain

catgut and had a laparotomy performed with chromic catgut. Half the controls were closed with plain catgut and the other half with chromic catgut. Following closure a dressing of collodion and cotton was applied and the animal was protected during the immediate postoperative period. The animals were observed at frequent intervals and a record made of the progress of wound healing. The results are shown in Table IV.

Results. It will be observed that of the 28 animals sensitized to plain catgut, 10 disrupted their abdominal wounds, 9 showed definite abnormal wound healing, while 9 healed normally. In the group of 16 sensitized to chromic catgut, 5 disrupted, 4 healed abnormally, and 7 healed normally. Of the animals sensitized to chromic acid 2 disrupted, while 3 showed abnormal wound healing and 3 healed normally. These results are in marked contrast to the 26 control animals of which only 1 showed evidence of abnormal wound healing and none disrupted. Abnormal wound healing was considered to take place when there was marked redness and edema about the sutures which extended to the wound margins causing thickening and eversion. The time of healing was invariably prolonged.

CLINICAL INVESTIGATION

Definite conclusions can be drawn only from unquestionable results. The factors in human

wound disruption are manifold and cannot be applied to controlled animal experimentation, nor is it possible to control these numerous factors so as to evaluate any one of them properly in a study of clinical cases. Presumptive evidence, however, may be obtained from a large series of cases if there is only one variable factor. The general observation that in disrupted wounds sutured with catgut, the catgut has largely disappeared suggests that it has been too rapidly absorbed. The same observation has been made in the wounds which disrupted in the guinea pig series. If every case on a surgical service were skin tested for catgut sensitivity and if it were found that a much higher incidence of wound disruption occurred in sensitive individuals and their results could not be explained by a consideration of the other causative factors one might consider the results presumptive evidence of the importance of this factor. We propose to make this study and present it in a subsequent paper.

However, suggestive facts are revealed by a study of the following groups: (1) pre-operative patients, (2) patients who had been operated upon and (3) patients surviving wound disruption.

Each of these groups was further subdivided into those which gave a history of some allergic manifestation and those which did not. There were 227 individuals in the first group, 75 in the second, and 30 in the third. All were subjected to the intradermal injection of the four solutions used in the skin tests in the guinea pigs except that they were diluted 1:10. This dilution made the irritation less marked but did not affect the interpretation of the reaction. Tests were made by introducing 0.1 cubic centimeter of the four solutions in the skin of the volar aspect of the forearm. They were recorded after 15 to 20 minutes and the criteria of a positive reaction consisted in erythema, enlargement of the wheal, and pseudopods from the wheal.

The results are shown in Tables V and VI. It will be observed that the allergic patients exhibited evidences of sensitivity more than twice as frequently as normal individuals. A history of an operation also increased the incidence of positive tests and when both of

these elements were combined the incidence rose still higher.

Table VI is an analysis of 30 cases which survived wound disruption at the Presbyterian Hospital since 1930.

All 5 cases which gave a history of allergy showed a positive skin test to one or more of the extracts. Twelve of the whole group had a previous operation and 7 of these gave a positive reaction. Of the 18 which gave no history of operation, 12 had a positive skin test indicating that this factor was of little importance in this group. However, it may be possible that the reaction to the catgut causing the disruption may have desensitized the individual resulting in a negative response to the skin test.

It is felt, therefore, that a history of allergy or a previous operation increases the likelihood of an individual being sensitive to catgut.

The reason for this relationship seems to be that allergic individuals are very frequently sensitive to a number of foreign proteins as shown by the various tests given in the allergy clinic. Catgut, being derived from sheep is a foreign protein but may undergo certain chemical changes in manufacture, particularly when it is chromicized. This process may alter the specificity so that we felt it important to use catgut extract itself rather than an extract of the fresh material. It was also considered possible that acquired sensitivity may be produced by an operation in which catgut is used, particularly if the individual has allergic tendencies.

SUMMARY

A. Laparotomies were performed on a group of 84 guinea pigs. 52 of these were previously sensitized to plain catgut, chromic catgut, or chromic acid. Twenty six were used as controls and the remaining 6 died of intercurrent infection.

1. Of those sensitized to plain catgut 33.7 per cent disrupted their abdominal wounds, 32.1 per cent of them healed abnormally, and 34.1 per cent healed normally.

2. Of the animals sensitized to chromic catgut 31.2 per cent disrupted, 25 per cent healed abnormally, and 43.7 per cent healed normally.

3. Those sensitized to chromic acid re

sulted in 25 per cent of disruption, 37.5 per cent abnormal healing, and 37.5 per cent normal healing

4 All of the 26 non-sensitized control animals healed normally except 1 which healed abnormally.

B. Three hundred and thirty-two patients were tested for sensitivity to plain catgut extract, chromic catgut extract, and chromic acid.

1. Fourteen and fifteen hundredths per cent of them gave a positive reaction to one or more of the solutions

2. Fifteen per cent of those patients with both a history of allergy and a previous operation were sensitive, while a positive reaction was obtained in 9.5 per cent of those with a history of operation alone

3. Seventeen and three tenths per cent of the patients with a history of allergy alone showed evidence of sensitivity while 2.3 per cent of the individuals without a history of either condition gave a positive response.

4 All 5 of the patients who disrupted their abdominal wounds and who had a history of allergy showed evidence of sensitivity, while 52 per cent of those without a history of allergy gave a positive response

CONCLUSION

Laboratory experimentation has demonstrated that guinea pigs may be sensitized to catgut. When this material is again introduced into such an animal a marked local reaction usually occurs at the site of its introduction. This frequently results in a rapid absorption of the catgut and often disruption of the wound.

Clinical investigation reveals a definite incidence of sensitivity to this suture material as determined by skin tests done with appropriate solutions. This incidence greatly increases with a history of allergy or a previous operation.

It is felt, that when catgut is to be used, the individual should be tested for sensitivity, particularly if he falls in the latter two groups.

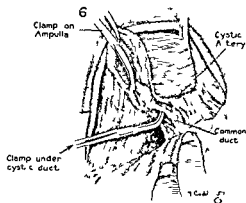
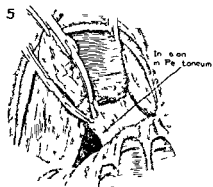
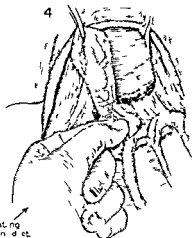
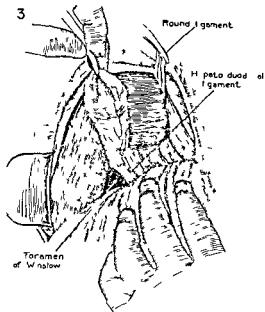
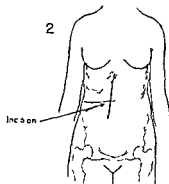
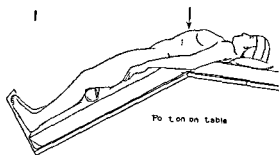
By this procedure one of the factors relating to disruption of wounds may be eliminated and in this way the incidence of this catastrophe may be reduced

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Figs 1 to 6 Cholecystectomy

The Surgical Procedures for Biliary Calculi—Elliott C. Cutler and Robert Zollinger

CLINICAL SURGERY

FROM THE SURGICAL CLINIC OF THE PETER BENT BRIGHAM HOSPITAL

THE SURGICAL PROCEDURES FOR BILIARY CALCULI

ELLIOTT C. CUTLER, M.D., F.A.C.S., and ROBERT ZOLLINGER, M.D., F.A.C.S.,
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IT IS our purpose to describe techniques for cholecystectomy, choledochostomy, and cholecystostomy in order to assist the young surgeon to avoid his mistakes of commission, most of which are the result of awkward or incomplete exposure of the operative field, and include such potential catastrophes as insecure ligation of the cystic duct or artery, angulation, or even ligation of the common duct and failure to recognize relatively common congenital abnormalities. Even more serious, and certainly more frequent, are the mistakes of omission, which usually are the result of the surgeon's failure to recognize and remove calculi in the biliary system beyond the cystic duct

CHOLECYSTECTOMY (FIGS 1-13)

General indications and pre-operative preparation The diagnosis of a diseased gall bladder can usually be confirmed by the oral administration of tetraiodophthalein sodium dye. When the gall bladder cannot be visualized, and no calculi are visible by this method, the test is repeated by the intravenous administration of the dye before cholecystectomy is recommended. Sosman has found that approximately 30 per cent of the gall bladders which appear to be abnormal after oral dye administration can be visualized by giving the dye intravenously. However, when the diagnosis is obvious, this procedure can justifiably be omitted, and in the presence of jaundice cholecystography is not indicated.

A history of at least one attack of biliary colic was obtained in more than 90 per cent of our cases, and in general the shorter the interval between the last attack of colic and the operation, the better the result of cholecystectomy. We have found biliary calculi in a high percentage of cases. In the patients who present only "gas" or vague indigestion as the major complaint, cholecystectomy should be advised with caution, for, as Graham has shown, the results are not good.

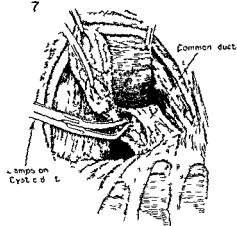
Approximately one-third of the patients at the Peter Bent Brigham Hospital with abnormal gall bladders by cholecystogram are submitted to surgery, although a much higher percentage had been recommended for surgery

Anesthesia. The choice of anesthesia is governed by the desires of the surgeon as well as the condition of the patient. Adequate relaxation of muscles by general anesthetics simplifies the operation. In elderly or debilitated patients, local anesthesia (novocain, 1 per cent, without adrenalin) can be used with satisfaction. Deeply jaundiced patients or those in whom there probably is liver damage should not be given large amounts of ether or chloroform as both are injurious to the liver parenchyma. Spinal anesthesia alone or a combination of nitrous oxide-oxygen and novocain may be used in such instances with a small amount of vinyl ether for the few moments whenever complete relaxation is necessary.

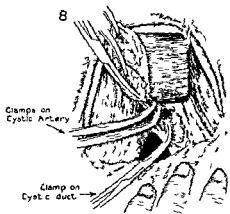
Position. The placing of the patient in the proper position on the operating table is of first importance in securing adequate exposure. Figure 1 depicts the value of breaking the table at the costal margin and having the body as a whole semi-erect, so that the weight of the liver tends to lower the gall bladder below the costal margin. Such a position acts as a natural retractor because the intestines have a tendency to fall away from the site of operation. The surgeon must remember to level the operating table before attempting to close or he will find that there is unnecessary tension placed on the structures of the abdominal wall

Incision and exposure. The high right rectus incision, as shown in Figure 2, is the one preferred. The skin incision must be a little longer than the peritoneal incision at the upper end, and therefore as a rule should begin above the costal margin. After deepening the incision to the rectus sheath the bleeding points should be tied to do away with unnecessary hemostatic forceps

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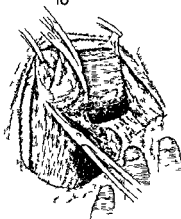
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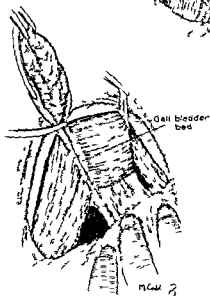
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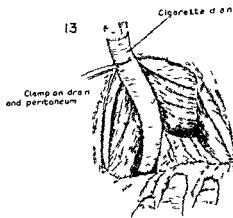
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Figs 7 to 13 Cholecystectomy

in the wound Pads or towels moistened in salt solution should then be placed over the fat to protect it from contamination. The rectus sheath is next incised, and the fibers split in a parallel fashion, picking up the blood vessels at each tendinous interruption. If care is used the majority of the underlying motor nerves can be preserved by retracting them to the upper and lower ends of the wound. The peritoneum should be opened just to the right of the xyphoid and continued to the umbilicus or below, depending upon the thickness of the abdominal wall and the length between the xyphoid and umbilicus. The peritoneum is then attached to the gauze or towels which already cover the subcutaneous fatty tissue. In our experience the transverse incision is not as simple in performance by junior surgeons as is the right rectus incision which we have described in detail. This may be due to the fact that the position of the gall bladder cannot be definitely determined beforehand and because, in our opinion, abdominal exploration and incidental appendectomy are not easily performed through this incision. However, we make no effort to remove the appendix routinely unless it can easily be brought into the field of operation. When the patient's position on the table is proper and the high incision made, the liver will drop down and the break in the table will tend to thrust the deep structures forward. A general abdominal exploration is now carried out. Following this, the site for cholecystectomy is prepared. Occasionally, when assistance is limited, the use of the main part of a Balfour self-retaining retractor may be used advantageously. With the right rectus incision described, however, a self-retaining retractor usually does not give adequate exposure to the right side, and as a rule we have found it better to use a single flat retractor at the right costal margin. Retraction of the mesial side is made by the left hand of the first assistant, which placed on a moist pad goes upward and inward to the upper border of the duodenum and holds downward and toward the midline all the structures below this. If the hand is correctly placed, the hepatoduodenal ligament, which contains the common duct, portal vein, and hepatic artery, the only anatomical structures endangered in this operation, is exposed. A deep, wide retractor may be substituted at the lower angle of the wound for the assistant's hand.

Figure 3 shows the wound opened, a retractor laterally, and the first assistant's left hand over a wet pad holding the intestines from the operative field. The fundus of the gall bladder is seized in a hemostat of the broad-nosed type. This is

applied only after the decision is made to remove the gall bladder, since to apply such a hemostat and then not remove the gall bladder would leave a devitalized point. A better exposure of the undersurface of the liver may be obtained if the operator places his right hand up over the dome of the liver and tilts it downward. Also, to aid in the exposure of the under surface of the liver, the round ligament may be divided between clamps (Fig. 3). The assistant, by maintaining traction on the round ligament, further aids in the exposure.

In the presence of jaundice of unknown etiology the hemostat should not be applied to the fundus of the gall bladder until the operator has determined whether this area is to be used for cholecystgastrostomy, or that cholecystectomy is necessary.

Details of the procedure Figure 4 shows the palpation of the common duct with the left hand of the operator. An effort is made to determine the consistency of the common duct, the presence of calculi and the condition of the head of the pancreas. Regardless of whether or not the common duct is to be explored, the region of the ampulla and cystic duct should now be accurately exposed. This is accomplished by exerting tension on the fundus of the gall bladder. The peritoneal attachment of the ampulla which is continuous with the structures about the common duct are visualized and incised (Fig. 5), thus liberating the ampulla of the gall bladder from its position against the common duct and cystic duct. A hemostat blindly applied to this region may result in extensive injury to the common duct because the ampulla may be lying parallel to it for a considerable distance. Better visualization of these structures is then obtained by applying a second hemostat to the ampulla and exerting gentle traction upon this at the same time that one pulls upward the clamp on the fundus. This puts the cystic duct under tension so that it can easily be identified. The cystic duct is followed down to the common duct. When this structure is visualized and the operator is certain (1) that the common duct need not be opened and (2) that cholecystectomy is to be performed, a thin-bladed right angle clamp (Mixer) is placed across the cystic duct (Fig. 6) about 1 centimeter from the common duct. Just above this a curved half-length clamp (Kelley) (Fig. 7) is placed on the cystic duct and the duct is divided between these clamps. The utilization of the exact type of clamps described simplifies both the division of the duct and the subsequent ligation of the proximal end of the duct. As the cystic duct is

cut across, the operator visualizes its size and consistency deriving further information as to the likelihood that stones have passed through its lumen. Traction is then exerted upon the clamp on the distal end of the cystic duct and the ampulla. This further exposes the deeper structures. The cystic artery should then be visualized and divided between the same type of clamps used in the division of the duct. Following the division of these structures (Fig. 8), the traction should be very gentle, lest the gall bladder be torn from the liver bed. The cystic artery and cystic duct are now separately ligated (Fig. 9) before the gall bladder is removed. We prefer to use a silk ligature but, if chromic catgut is used, a small size is preferable. The peritoneal surface of the gall bladder close to the liver should now be incised on both sides either with a knife or scissors following which, by careful dissection in the loose fatty tissue between the gall bladder and the liver, the gall bladder can be separated from its bed and drawn out of the wound without injury to the liver and without dividing any sizable vessels (Fig. 10). Before the gall bladder is finally removed from its cleft in the liver, advantage may be taken of the traction which can be exercised upon it, fine sutures are placed to close the peritoneal opening about the common duct, the area of the cystic duct and artery, and the open bed of the gall bladder in the undersurface of the liver (Figs. 11 and 12). The round ligament is reapproximated in the cases in which it has been divided, and the rent in the falciform ligament likewise is repaired. The omentum may be placed up into the region of the gall bladder bed to aid in walling off this area.

It has now become a frequent practice in simple uncomplicated cases to close such a wound without drainage. If gross infection has been present or if the wound is not absolutely dry and hemostasis or closure of the liver bed is incomplete it is wiser to leave a small cigarette drain which should extend to the renal fossa and lie against the cleft in the liver from which the gall bladder has been removed.

Closure then proceeds after the accustomed method of each operator. If the transverse incision or the oblique Kocher incision is used tension sutures, even in the face of infection, are not necessary. We prefer to close the wound with silk, using a continuous suture for the peritoneum and transversalis fascia, and interrupted mattress sutures for the rectus fascia, subcutaneous fat and skin. A chromic catgut suture, size No. 1 or 2 is frequently used for the peritoneum and fascia layers. If the common rectus muscle splitting

incision is utilized, particularly if the patient is elderly, obese, or if there be much infection it is always wise to use several silk worm gut or steel wire tension sutures.

CHOLEDOCHOSTOMY AND CHOLECYSTECTOMY (FIGS. 14-21)

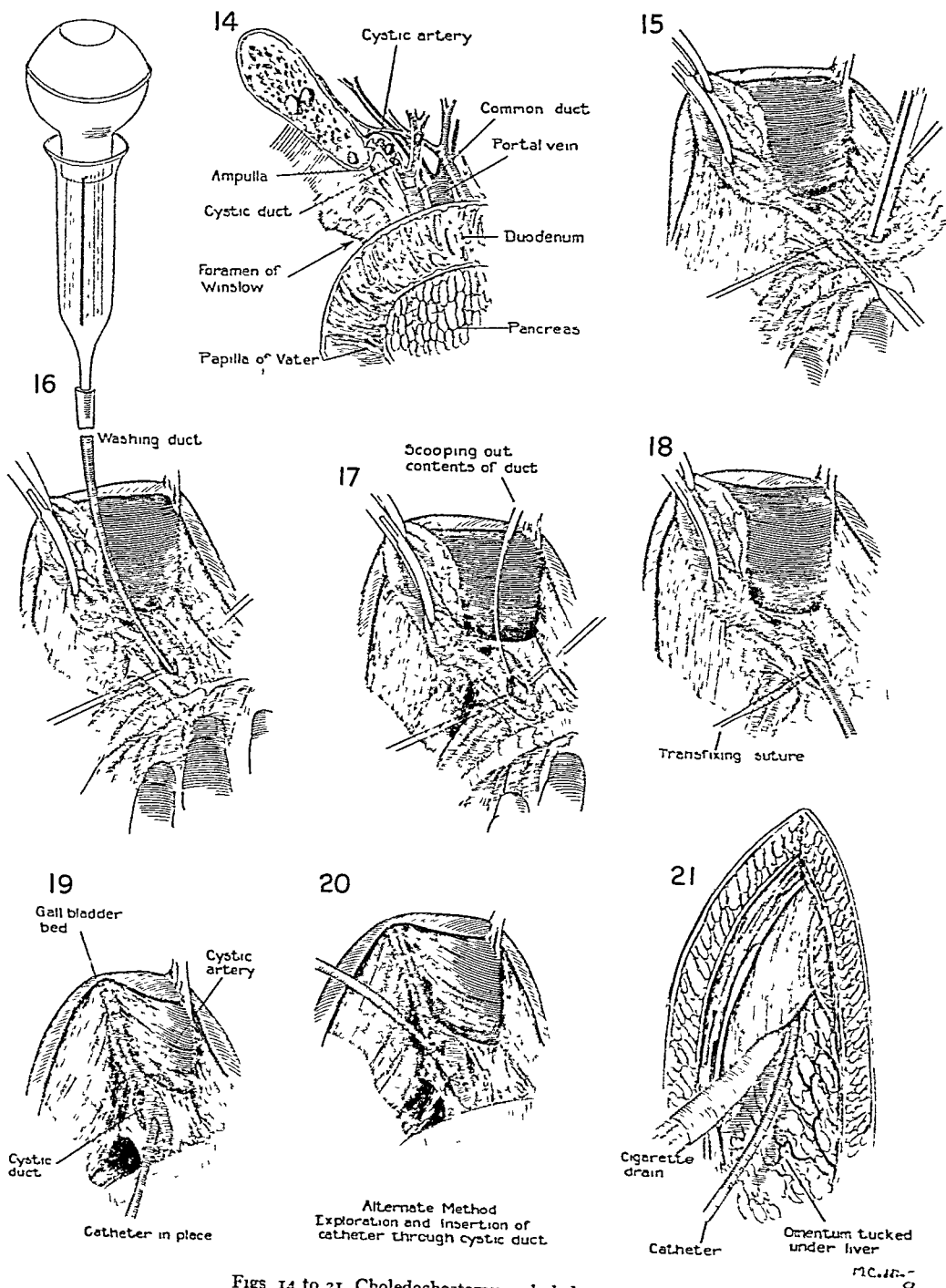
General indications and pre operative preparation. The decision to explore the common duct depends not only upon the history and the symptoms but upon the anatomical findings presented to the surgeon by palpation and visualization at operation. We have used the following criteria as indications for exploring the common duct:

- 1 History or presence of jaundice
- 2 Cholangitis associated with cholelithiasis.
- 3 Recurrent symptoms after cholecystectomy
- 4 Frequent attacks of gall stone colic
- 5 Irreversible involuntary vomiting
- 6 Suggestion of stone by palpation.
- 7 Dilated or thickened common duct
- 8 Contracted thickened gall bladder
- 9 Dilated cystic duct
- 10 Thickening of head of pancreas
- 11 Many small stones in gall bladder and cystic duct.

The first five indications are obtained from the history. Indications 6 to 11 are obtained by observation and palpation. By following these indications we have found that it is necessary to explore the common duct in about 40 per cent of our cases. Over a period of several years at the Peter Bent Brigham Hospital the incidence of common duct stone was as high as 22.8 per cent of all patients operated upon for cholelithiasis. This would indicate that almost one fourth of the patients undergoing cholecystectomy should have the common duct explored and the young surgeon therefore must be as familiar with the technique of exploring the common duct as he is with the technique of cholecystectomy. Figure 14 depicts, schematically, the common locations of calculi.

In the presence of increased or severe jaundice, it is usually desirable to delay operation for a few days to see if general improvement will follow. Unless the icterus is of very long duration with a prolonged bleeding and clotting time we have not been particularly impressed with the dangers of hemorrhage when the tissues are handled carefully and meticulous hematemesis is carried out. High carbohydrate intake, either orally or parenterally is advised in all cases for a time before operation.

Exposure. Figure 15 depicts the exposure and the stage at which the common duct is exposed. The surgeon should note the size of the duct the



Figs 14 to 21 Choledochostomy and cholecystectomy.

M.C. 11-10

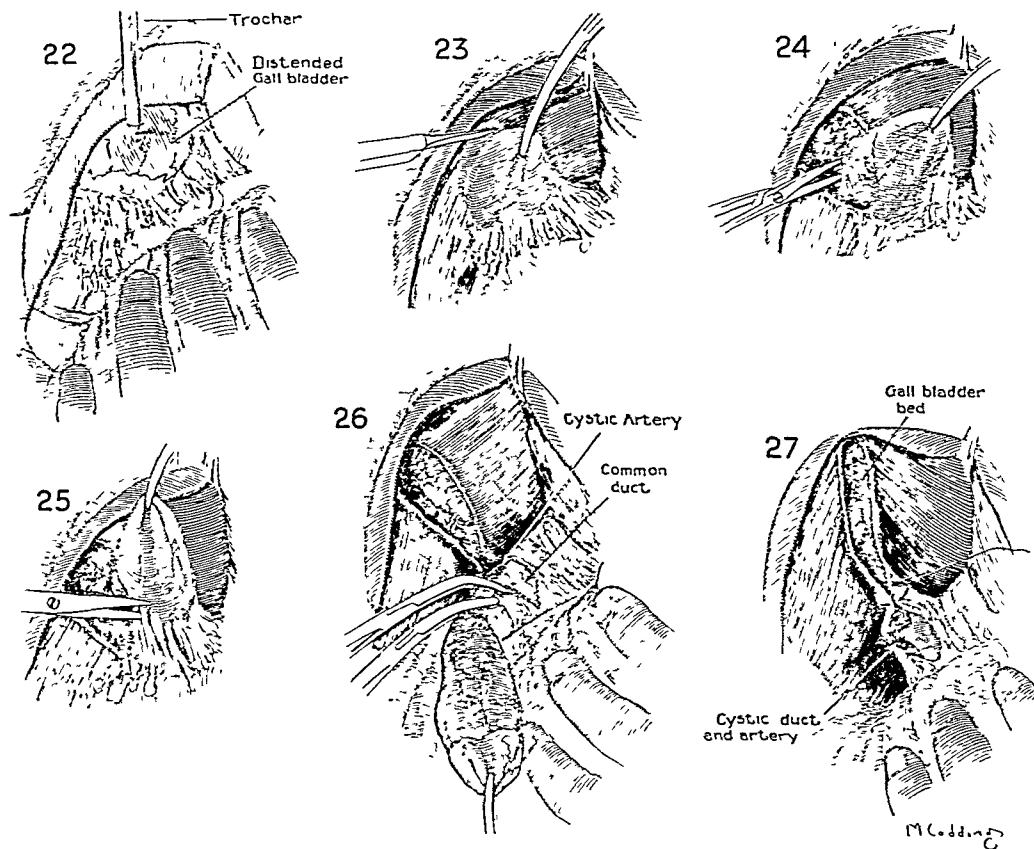
thickness of the wall, the presence of inflammation and any other pathological findings, together with the factors mentioned previously, to determine whether exploration of the common duct is necessary. In doubtful situations the common duct is identified by its position in the hepatoduodenal ligament, by its direct relation to the cystic duct, by the presence of a vein running over its wall, and by aspiration of bile through a fine needle.

Details of the procedure To explore the common duct, two silk sutures are placed a few millimeters apart in its wall at a point, as a rule just below the entrance of the cystic duct into the common duct (Fig 15). By traction on these sutures and by traction on the gall bladder, which is never disconnected from the duct system until after the procedures upon the common duct have been completed, an excellent exposure of the field is provided. The common duct is then opened between these sutures over a distance of at least 1 centimeter (Fig 16). A variation of this procedure suggested by Halsted has been utilized in certain cases, i. e., in cases in which the cystic duct is sufficiently large, it may be possible to explore the common duct through it. If this is to be done, the cystic duct is opened between the same type of sutures placed just above its point of junction to the common duct. Exploration upward is usually impeded by the angle at the juncture of the two ducts so that the common duct must be opened to remove the stone after which it can be closed tightly and drainage carried out via a catheter in the cystic duct. Whether the cystic duct or the common duct be opened, the operation proceeds in the same fashion. With the duct held open, it is customary to explore the common duct first with a small English webbing catheter, size No. 10 or 12. This should be gently inserted first downward and then upward to test the patency of the duct. If this is manipulated with the right hand and the left forefinger is in the foramen of Winslow, one may be able to feel the stone against the catheter, even if the catheter seems to pass freely through the papilla of Vater. After this exploration the simplest method of securing the stone should be utilized. This method is depicted in Figure 16, and consists in instilling normal salt solution from a syringe into the catheter, irrigating both upward and downward. In a great many instances the stones which are light in weight are dislodged by the fluid just as wax is dislodged in the ear, and the stones float into the opening in the duct and can be picked out. The next step (Fig 17) is to insert a small scoop which should have a pliable handle

which can be bent to the necessary curve of the duct in each case. This should be passed upward in both hepatic ducts and then downward into the region of the papilla. Stones may be easily brought out with such a scoop. Sometimes in the case of a stone impacted in a diverticulum to one side of the papilla the left forefinger and thumb may fix the stone and with the scoop break it into fragments. These may be removed either piece meal or by washing them into the opening with a syringe of warm salt solution. The scooping is often carried out before the irrigation. Care should be taken in the use of scoops and all other metal instruments, lest perforation occur or cicatrization be increased. When the operator has determined that no further stones are present in the duct he should test the patency of the papilla by inserting an English webbing olive tipped catheter, sizes No. 14 to 16, which he should be able to pass without resistance into the duodenum (Cheever).

We do not believe that an attempt should be made to dilate the papilla once its patency has been established. Experiments have shown that the papilla returns to its original size or smaller as a result of scar formation from extensive dilatation (5). Likewise it has been shown (5), following dilatation of the papilla of Vater in patients, that during the first few days after this procedure there is considerable increase in resistance to the escape of fluids through the common duct into the duodenum, as is demonstrated by consistent elevation of the perfusion pressure.

In cases in which the jaundice has been of long standing and particularly when there has been a great deal of vomiting preceding the operation, it has been our custom to instill 50 cubic centimeters of a 50 per cent glucose solution into the duodenum by way of the catheter used to test the patency of the papilla for the purpose of giving the patient food for the next few hours. After the manipulations upon the duct are finished a small soft, open end common duct rubber catheter is inserted into the common duct either through the opening made in the duct (Fig 19) or down the cystic duct (Fig 20) into the common duct. The opening in the duct is closed securely about the catheter and tested for possible leakage by the injection of saline through the catheter. We always use fine black silk sutures. One of these sutures should be engaged in the rubber of the catheter about 1 inch from the tip and then lightly engage the outer coat of the duct (Fig 18). This ligature is then tied and suffices to hold the catheter in the position desired. Since this suture



Figs 22 to 27 Cholecystectomy

includes only a few millimeters of duct tissue, it is deliberately tied very tightly, and will eventually become free in perhaps a week so that the catheter can be pulled out without any discomfort to the patient. Following the placement of this catheter (Figs 19 and 20), the gall bladder is removed according to the technique described under cholecystectomy.

The closure of this wound is modified from that described in cholecystectomy only by addition of the catheter as well as a small cigarette drain. It is our custom to place a skin suture at the point where we wish the common duct catheter to be held, tying this about the catheter to hold it in position. In many uncomplicated cases the cigarette drain is omitted. The catheter or drain, or both, may be brought out through a separate stab wound lateral to the incision. The surgeon must be certain that the catheter is connected to a drainage bottle promptly after transfer from the operating table.

CHOLECYSTECTOMY FROM FUNDUS (FIGS 22-27)

General indications. Cholecystectomy from above, as a rule, is limited to cases in which exposure of the region of the cystic duct is difficult and perhaps hazardous, and the surgeon feels that it is much safer and easier to remove the gall bladder from the fundus downward. Extensive adhesions and an acutely inflamed gall bladder, especially with a large calculus impacted in the region of the ampulla, are some of the factors which make such a procedure the wiser choice.

Details of the procedure. Having exposed the fundus of the gall bladder at the edge of the liver, the surgeon now determines, from the appearance of the operative field, whether it is safer to remove the gall bladder from the fundus downward or to proceed with the classical cholecystectomy. If the former method is adopted, it is wiser to empty the gall bladder of its contents immediately through a trochar, in order that there may

thickness of the wall, the presence of inflammation and any other pathological findings, together with the factors mentioned previously, to determine whether exploration of the common duct is necessary. In doubtful situations the common duct is identified by its position in the hepatoduodenal ligament, by its direct relation to the cystic duct, by the presence of a vein running over its wall, and by aspiration of bile through a fine needle.

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above, in that the indications for this procedure are usually those which demand cholecystectomy. However, in patients who are very poor risks and particularly in patients with gross purulent infection of the gall bladder, it may become the operation of choice.

Anesthesia Novocain infiltration anesthesia is advisable.

Position, incision and exposure The position is the same as that for classical cholecystectomy. The incision should be as small as will conveniently expose the fundus of the gall bladder. It is usually preferable to place the incision over the maximum point of tenderness to insure proximity of the fundus of the gall bladder to the overlying incision and aid in anchoring it to the peritoneum at the time of closure.

Walling-off gauzes are inserted completely around the fundus of the gall bladder to wall off the remainder of the peritoneal cavity.

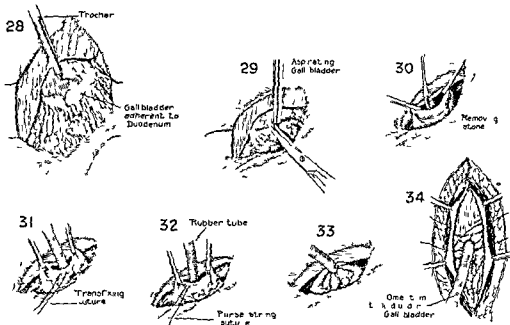
Details of the procedure Figure 28 shows aspiration of the gall bladder through a trochar. Figure 29 shows enlargement of the trochar opening so that a "sucker" can be inserted into the gall bladder to aid in the evacuation of its contents. A culture of the contents of the gall bladder is taken. Suction rapidly evacuates the fluid contents. The cavity of the gall bladder may be washed with salt solution, which tends to dislodge coherent stones, and on the whole the procedure is far less traumatizing than the use of metal scoops and spoons. Figure 30 shows a

step in removing stones with a scoop or spoon. When the gall bladder has been thoroughly emptied and irrigated and no stones remain, a soft piece of rubber tubing or an open-end common duct catheter is placed in the gall bladder and held there by a transfixing suture (Fig. 31). A pursestring suture is then placed about the opening in the gall bladder and the opening tightened around the catheter or tube (Figs. 32 and 33). Before the peritoneum is closed, sutures are placed between the fundus of the gall bladder and the peritoneum in order to anchor the gall bladder at this point. It is important to adjust this point of fixation to the position the gall bladder will naturally assume with the patient erect.

Closure is made as is customary, care being taken to pack the omentum about the gall bladder.

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Figs 28 to 34 Cholecystostomy

be less bulk to the gall bladder in the way of subsequent steps. The trochar may be thrust immediately into the fundus of the gall bladder (Fig. 22) and the gall bladder emptied of its contents by pressure upon it and suction through the trochar when the trochar is removed one or two curved hemostats are placed so as to prevent the further regurgitation of bile through the opening made by the trochar. Or if there be considerable infection present and the dangers of soiling the field from the contents of the gall bladder are felt to be of serious consequence then a pursestring suture may be laid in the top of the fundus of the gall bladder and the trochar thrust in the middle of the circle of the previously laid suture. As the trochar is withdrawn this pursestring suture is tightened to prevent the escape of the contents of the gall bladder. Figures 33 and 34 depict the beginning of the dissection of the gall bladder from its cleft in the liver. It is well to begin the first incision into the serosa of the gall bladder with a knife. Following this and especially if the zone of loose areolar tissue beneath the serosal coat is distended or edematous the remainder of the dissection is easily carried out with a pair of scissors (Fig. 25). The main principle is to dissect as close to the gall bladder as possible if necessary leaving most of the serosa attached to the liver bed. It is the

removal of the lining of the gall bladder only that is important. In some instances, because of advanced inflammatory changes, the full thickness of the gall bladder is removed excepting that portion in the liver bed. Phenol or electrocoagulation is applied to the remaining mucosa to complete its destruction. As the surgeon exposes the cystic duct he should be sure (1) that the clamp (Fig. 24) is placed so as to include both the cystic duct and artery, and (2) that the inclusion of any part of the common duct is avoided. With the gall bladder thus removed the cystic duct and cystic artery may be ligated either jointly or separately. Closure of the denuded gall bladder bed by utilization of what is left of the serosa of the gall bladder should be attempted (Fig. 27) with a continuous or interrupted silk suture.

Closure. These steps are carried out in exactly the same fashion as in the operation for cholecystectomy from above except that in cases in which removal of the gall bladder is from above downward it is always wiser to insert a cigarette drain which lies in the cleft of the liver and extends to the renal fossa.

CHOLECYSTOSTOMY (FIGS 28-34)

General indications and preoperative preparation. This operation is less frequently performed than the operation of cholecystectomy from

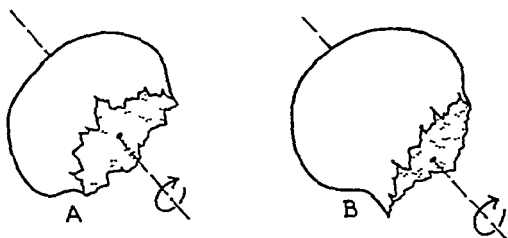


Fig 2

Fig 2 A, Diagram showing center of rotation of head fragment of left hip as considered in the present discussion as seen from the front. Note that rotation is always in an upward direction anteriorly. B, Shows the reverse curve of the head and neck junction which will impinge against the acetabular rim if rotation is much over 100 degrees as is also shown by x-ray in Figure 1 to the left.

Fig 3 Diagram. The clear circle represents the fractured surface of the head fragment, the shaded one the neck fragment as seen from the side. 1, The two are superimposed before any displacement has occurred. 2, Displacement occurring. The point marked X represents the locking of fracture spicules resulting from separation of fragments above and in front. The ellipse of the shaded

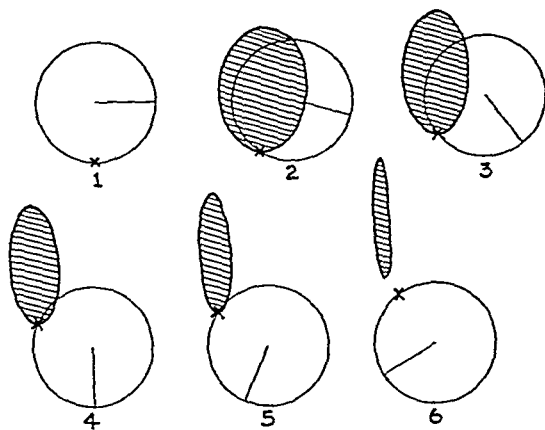


Fig 3

circle occurs as external rotation of the femur takes place following fracture. The clear circle (head) rotates due to the locked spicules. 3, 4, and 5, Continued external rotation of neck fragment with upward displacement carrying head into further rotation. 6, Fragments finally unlocked with complete displacement.

sharp contrast to the usual fracture history today. The question arises whether the patient makes a misstep, twisting the hip slightly, fractures it and falls, having sustained the fracture by torsion, or falls and fractures the hip by impact with the floor. Our feeling is that most of these patients have a fractured hip before they come to rest on the ground or floor.

Length of hospital stay and expense incident to

a fracture of the neck of the femur. The average patient who enters the ward of most hospitals with a fracture of the neck of the femur is a rather unwelcome guest for a prolonged stay. Our series showed 41 patients, excluding those who died shortly after admission or were transferred elsewhere during treatment, who stayed in the hospital for an average of 122½ days each. Of these patients 24 occupied ward beds at a cost of \$5.48

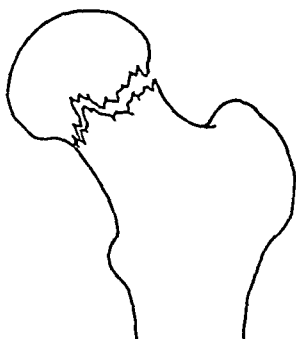


Fig 4

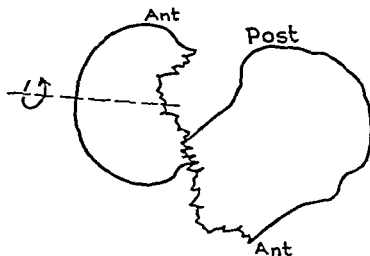


Fig 5

Fig 4 Diagram of left hip from the front showing that the location of earliest separation at the line of fracture is above and in front and that contact of spicules persists at the lowest point of line of fracture. It is the locking of these spicules at this point which causes rotation of the head fragment to occur. Incomplete, undisplaced, or fragmented fractures will not present this same mechanical situation and therefore rotation will not occur.

Fig 5 Diagram showing the left hip from above with the meshing of spiculations at the postero-inferior point of

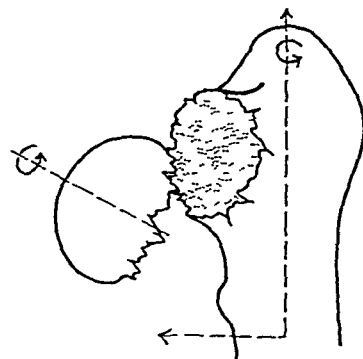


Fig 6

the neck fracture line which has carried the head forward in rotation 90 degrees due to external rotation, upward displacement, and adduction of the femoral shaft which has occurred following fracture.

Fig 6 Diagram of left hip from in front showing locking of spicules at the inferior margin of the fracture which has caused the shaft fragment of neck to carry the head fragment in rotation, forward and upward in front about 160 degrees. Beyond this point fragments unlock as complete displacement occurs.

FRACTURES OF THE NECK OF THE FEMUR

A Critical Analysis of Fifty Consecutive Cases

MATHUR CLEVELAND, M.D., F.A.C.S., and DAVID M. BOSWORTH, M.D.,
New York, New York

THE extensive literature on the subject serves to emphasize the fact that fracture of the neck of the femur presents one of the most difficult problems in bone and joint surgery. The numerous technical procedures which have recently been advocated for the reduction and fixation of these fractures indicate a feeling of dissatisfaction with results obtained by the formerly accepted methods. Some of these procedures which are so enthusiastically proclaimed may prove to be real advances in treatment but time will be required to gather statistical data. The reports of new operations with one or several cases followed for a year or less are too inconclusive to warrant serious attention.

The thought and action of the majority of surgeons who have treated these fractures have been dominated by the teaching of Royal Whitman, to whom we owe a debt of gratitude for his pioneering in principles of treatment. It is unfortunate, however, that he did not report any final results.

This series of 50 consecutive fractures of the neck of the femur is presented from the surgical and orthopedic services of St. Luke's Hospital over a 5 year period from January 1930 to

From the Surgical and Orthopedic Services of St. Luke's Hospital

December, 1934. These patients are from the wards and private pavilion, representing the work of 15 surgeons which of course, means considerable variation in technique, but the principles of treatment have been similar.

Age. These 50 patients were an elderly group with an average age of 64½ years. The youngest were 36 and 40 years old respectively, 62 per cent were in the seventh, eighth and ninth decades of life, while the remaining 38 per cent were in the fourth, fifth and sixth decades.

The age distribution is as follows:

Age in years	Number of patients	Per cent
31-40	2	4
41-50	6	12
51-60	11	22
61-70	11	22
71-80	14	28
81-90	6	12

Sex. The sex incidence shows 39 of 50, or 78 per cent, were women; a ratio of women to men of almost 4 to 1. Our feeling is that any series of fractures of the neck of the femur from a similar hospital will show a marked preponderance of women.

Type of injury producing the fracture. This is often trivial; a simple fall, tripping over a rug, some slight misstep. Only 3 of the 50 were injured by being struck by an automobile which is in



Fig. 1. The original case of derotation for fracture of the neck of the femur. Left shows the pointed femoral neck caught on the head and rotating it upward and forward in front slightly more than 90 degrees so that the anterior border of the head fragment now lies above. The portion of the neck attached to the head at this situation reverses

the curve of the head and it would form a point of impingement against the acetabular margin in full abduction even though union should occur without derotation. Center shows derotation with perfect matching of the bone ends. Right shows solid perfect union with no absorption in 6 months.

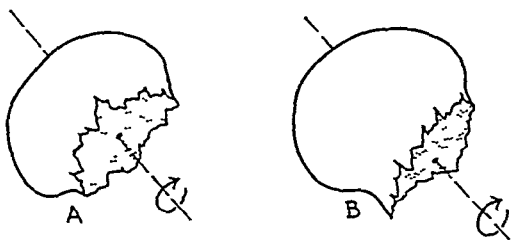


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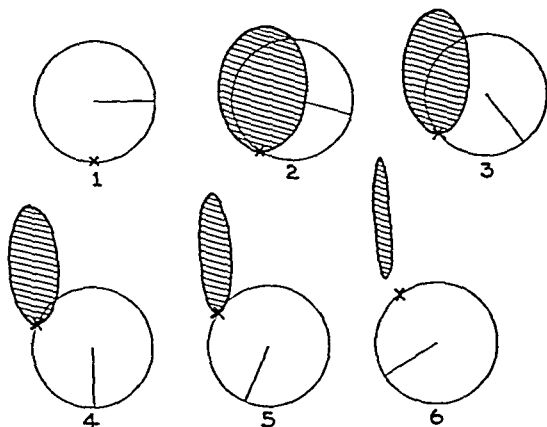


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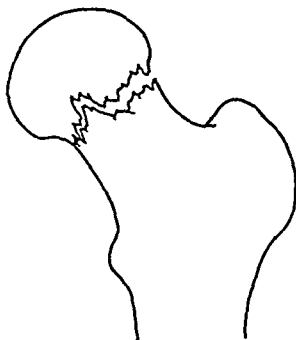


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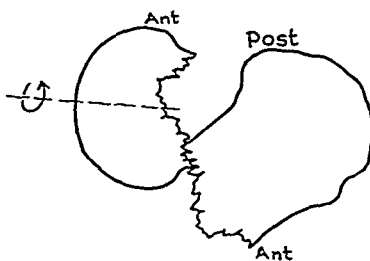


Fig 5

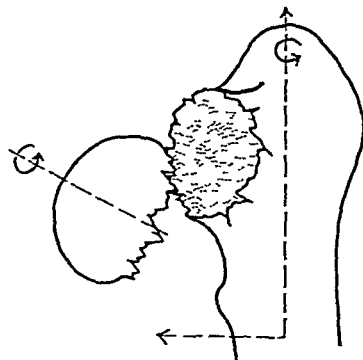


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Fig. 7 a Mismatching of pterional sutures is clear evidence of head rotation and demands derotation for best chance of union. b Note contour of upper head/neck margin with projecting eminence due to rotation of head fragment bringing antero-inferior border of head above. If union

occurs this way abduction will be limited by this contour or faulty articular alignment. c Rotation of head causes end-to-end position but no apposition. Spicules lock fragments apart. Increased blood clot between fragments favors non union.



Fig. 8 Angulation of fragments with end-on position as shown in a is direct evidence of rotation of head and mis-

matching of fragments. Derotation of head 160 degrees shown in b.

per day or a total of \$671.50 each, excluding the cost of the roentgenograms and the use of the operating room and rating the surgeon's services gratis, as they are. Very few of these ward patients pay even a small fraction of the cost of their care so the hospital assumes a heavy financial burden in treating them.

The cost for a private patient is little short of appalling. There were 17 private patients who

stayed in the hospital an average of 134 days. Figuring their expense at an absolutely minimal rate of \$7.00 per day it brings the bare charge for a room to \$1000 roentgenograms the day and night nurses' use of the operating room and lastly the surgeon's fee being excluded. The economic problem for either class of patients can not be denied.

Method of treatment. This series of patients has been treated by what are considered conservative methods. In 40 manipulation was used; legs were put in varying degrees of abduction and internal rotation and were immobilized by a plaster of Paris spica bandage. In 5 manipulation and immobilization were not used. Five patients were treated with traction.

END RESULTS

Mortality. This is an elderly group of patients with relatively short expectancy of life. From January 1930 to July 1936 a 6½ year period there were 11 deaths in the 50 cases or a gross mortality of 22 per cent. Four of these deaths



Fig. 9 Non union resulting from 90 degree rotation of head. Fragments could not have been opposed without derotation of head.



Fig. 10. Case 6, A B, a housewife of 57, with an undisplaced fracture of the neck of the left femur, treated by sandbag immobilization for 68 days. She has a perfect end-result without shortening 6 years after her injury. The roentgenograms show the original fracture and the 6 year end-result with the right hip for comparison.

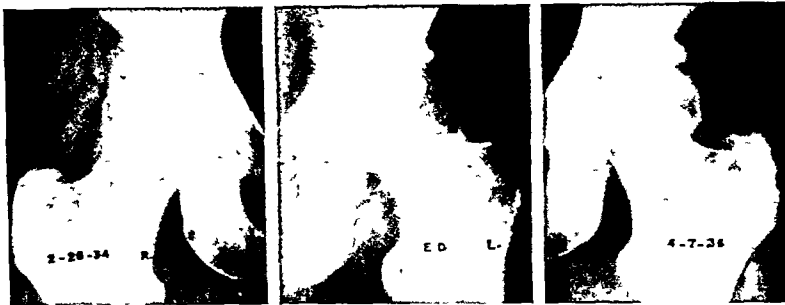


Fig. 11. Case 47, E D, a clerk of 50 years, with an undisplaced fracture of the neck of the left femur, treated by a plaster-of-Paris spica for 98 days. She has a perfect functional and cosmetic end-result with a little shortening of the femoral neck and a slight tilt of the head. The roentgenograms show the original fracture of the left hip and the end-result 2 years later.

occurred from unrelated causes from 7 months to 3 years after the injury. Of these 4 patients, 1 had a united fracture. The immediate mortality in which the injury played the important part was 7, or 14 per cent. The average age of those dying was 76 years, which is 11 years greater than the group average. The contributing causes of death were senility, myocardial disease, and cerebral arterial disease. There is a marked difference in immediate mortality between ward and private patients. Of the ward patients 6 of 33, or 18 per cent, died under treatment, while 1 private patient of 17, or 5.8 per cent, died under treatment. This difference is in a large part due to the better and more constant care which special nursing insures. This factor is paramount in treating any old person by immobilization in a plaster-of-Paris spica bandage.

EVALUATION OF RESULTS

The end-results of fracture of the neck of the femur are not easy to evaluate. Excellent results with complete or almost complete restitution,

anatomical and functional, are rare. If union is the only criterion, the problem is simplified. A united fracture is a success, and an ununited fracture is a failure. Pain, limp, limited motion, and attendant disability rank higher with the patient than union or non-union. Union of the fracture does not always insure freedom from pain and disability, nor does the patient with non-union invariably suffer these symptoms.

We have studied the roentgenograms of all these 50 patients and have personally examined 30 of the 39 survivors with check-up roentgenograms. The remaining living patients have been seen in follow-up. The end-result in the dead is known in every instance but one. We know the end-result in 48 of these 50 patients, a 96 per cent follow-up. Those unknown are a woman who died 3 years after her injury and a man who has so far declined to be examined.

Union of the fracture. There were 19 patients of the 48 known end-results who had bony union of their fractures. This makes a variable percentage as one chooses to figure it: 38 per cent of



Fig 12 Case 49 N D a housewife of 40 years who walked into the clinic 6 weeks after she had twisted her left thigh. A roentgenogram revealed an undisplaced fracture of the neck of the femur. She was kept on crutches for 4 months without immobilization. She has a perfect anatomical, cosmetic and functional end result. The roentgenograms show the recent undisplaced fracture of the left hip and the same healed 1 year later in anteroposterior and lateral views.



Fig 13 Case 9 E S a housewife of 44 years with a displaced fracture of the neck of the left femur treated by reduction and plaster of Paris spica for 78 days. The end result 6½ years after her injury shows bony union, a little shortening, no lump and a little pain. She walks very well. The roentgenograms show an original displaced fracture with definite evidence of rotation of the femoral head. Six and one half years later they show union with *coxa vara* at least 1 inch shortening but no degenerative changes in the femoral head.

the entire series of 50, 39.5 per cent of the known 48, or 46.5 per cent of the 41 surviving long enough to get union. The average age of these patients with union is 59.5 years, about 5 years younger than the group average.

Of these 19 patients who had united fractures, 10 had no original displacement. We prefer to



Fig 14 Case 29 J C a 57 year old hospital clerk with a fracture of the neck of the left femur with original displacement not reduced but a plaster of Paris spica was applied and maintained for 89 days. Three and one half year follow up shows a firmly healed fracture but with limp, pain, shortening and motion limited somewhat. The roentgenogram shows at 3½ years a marked *coxa vara* of the left hip with shortening and some productive change in the femoral head. This is a rare case of union with malposition of the fragments.

discard the term impacted fractures because we have in no instance in this series noted any bulging of the cortex or compression of the spicules such as is seen in impacted fractures elsewhere. Of the patients whose fractures showed no original displacement, 8 have an almost perfect range of motion, little or no shortening, and no lump and may be rated as excellent from cosmetic, functional and anatomical standpoints. The 2 others



Fig 15 Case 45 M J a 75 year old housewife with a fracture of the neck of the left femur with original displacement reduced twice and maintained in plaster of Paris spica for 105 days. A 3½ year end result which is clinically excellent. She walks well with no pain or limp and very little limitation of motion. The roentgenogram shows some shortening of the femoral neck with degenerative changes in the head of the left femur.

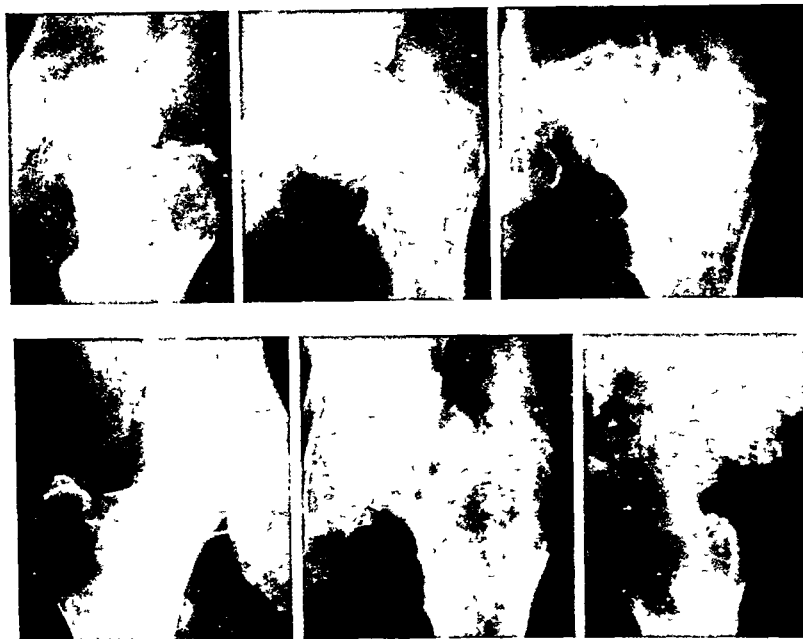


Fig. 16 Case 10, S. E., a housewife of 54 years, with a fracture of the neck of the left femur, treated with reduction and a plaster-of-Paris spica for 70 days. This fracture showed no original displacement but was displaced by manipulation. A 6 year follow-up shows union with 1 inch shortening, a wide range of motion, and only a little pain. The roentgenograms show the original fracture without displacement. There is some displacement 3 months later, and 6 years later the fragmentation of the femoral head is marked with union in coxa vara. If not manipulated this patient should have had a perfect end-result.

with no original displacement were so vigorously manipulated in a mistaken attempt to reduce the fracture that, though they united, there resulted marked changes in the femoral head which led to partial absorption, stiffness, and limp.

The 9 remaining patients with union all showed original displacement of the fragments and only 2 of these had perfect functional, cosmetic, and anatomical results. The 7 others showed either malunion or degenerative changes in the femoral head or both. The secret of an excellent result in a fracture of the neck of the femur in our series is one that shows no original displacement and is then unmolested other than to protect it until union takes place.

Union in relation to function. Over 60 per cent of the patients with union showed a wide range of motion in hip and knee. Medial rotation of the hip was more apt to be limited than any other motion.

The 10 patients with excellent results all walk well and are not in the least incapacitated. Of the 9 patients who had union with varying degrees of fragmentation or degeneration of the femoral

head or with angulation of the fragments, 6 walk well with very little disability, while 3 walk badly with pain and disability. One of these had pain sufficient to consult a surgeon at another hospital where an arthrodesis of the hip joint was performed.

Non-union of the fracture. There are 20 living patients who we know have non-union, and of the 11 dead, only 1 had union. The average age of these patients with non-union was 68.5 years, 9 years above the average age of those with union and 4 years above the average age for the group. Of these 20 patients with ununited fractures, 7 walk

TABLE I — SUMMARY OF UNION AND NON-UNION OF FRACTURE

	Number	Union		Non-union	
		Number	Per cent	Number	Per cent
Total known	48	19	39	29	61
Total living	38	18	47.4	20	52.6
Total died	10	1	10	9	90



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Fig. 14 Case 20 J C a 57-year-old hospital clerk with a fracture of the neck of the left femur with original displacement, not reduced, but a plaster-of-Paris spica was applied and maintained for 90 days. Three and one half years follow-up shows a firmly healed fracture but with limp, pain, shortening and motion limited somewhat. The roentgenogram shows at 3½ years a marked coxa vara of the left hip with shortening and some productive change in the femoral head. This is a case of union with malposition of the fragments.



Fig. 15 Case 43 M J a 75-year-old housewife with a fracture of the neck of the left femur with original displacement, reduced twice and maintained in plaster-of-Paris spica for 105 days. A 3½-year end result which is clinically excellent. She walks well with no pain or limp and very little limitation of motion. The roentgenogram shows some shortening of the femoral neck with degenerative changes in the head of the left femur.

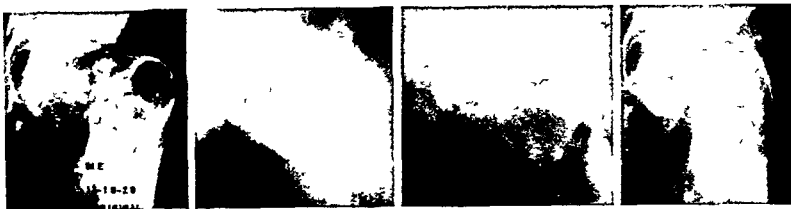


Fig 18 Case 5 M E, a dressmaker, 65 years of age, fractured the neck of the left femur with original displacement. She had two attempted reductions of the fracture, and after each the roentgenograms were unreadable. Her latest roentgenogram shows non-union and the follow-up examination reveals 6 years after her injury that she is able to walk only short distances using a cane. She has a marked limp, pain, and great disability. This patient is shown to emphasize the importance of having roentgenograms which can be interpreted.

fact that a fracture of this type, if correctly diagnosed, is almost certain to unite if it is not meddled with. The one non-union in this group was definitely displaced originally and not recognized as such.

The method of treatment in relation to union of fracture is shown in Table III.

2. *Failure to reduce the fracture* in various ways is the commonest single factor we have encountered. There were 16 patients in this series whose fractures were not reduced. Anteroposterior roentgenograms must be supplemented with lateral views of the hip to insure end-to-end apposition. It is not uncommon to see one of these fractures which is apparently reduced in which the rotation of the head fragment persists, and the fractured surfaces will not lock in apposition. This rotation of the femoral head is herewith described in detail, because we consider it of very great importance. Failure or inability to correct this rotation has, we believe, accounted for many of the non-unions.

3. *Rotation of the femoral head*. Displacements of the femoral head have been emphasized by Magnuson, Darrach, and Stimson, but the following conception of rotation has, we think, not been mentioned by them. It was first drawn to our

attention by one of us (D M B.) in February, 1934.

We had previously found that end-to-end position was frequently secured without close apposition of fragments, that is, while the fragments might be end to end, the serrations or spiculations did not match and that they were either locked and angulated or held apart for a variable distance. At that time a patient was encountered in whom an open reduction seemed advisable. At open reduction the fragments could be easily placed end to end, but they did not match and mesh with each other. A gap existed between them in places of over one quarter of an inch. While cleaning off the capsular attachment on the anterior margin of the acetabulum, the periosteal elevator caught on the anterior border of the head fragment rotating it forward and downward about 100 degrees. The assistant who was holding the leg then remarked that it seemed to assume a more normal position. On inspection of the fracture site, the fragments were seen exactly to match with each other, and a perfect reduction was present (Fig. 1). The significance of this fact did not strike us at once, but a few months later during another open reduction the same findings were confirmed, and following this, cases suitable



Fig 19 Case 46, L S, a housewife 61 years of age, with a fracture of the neck of the right femur, with original displacement of the fragments. The fracture was reduced and a plaster-of-Paris spica was applied. The reduction did not suit the surgeon so a second reduction was done, and the fragments were separated by further internal rotation and wider abduction. The end-result was non-union and the patient is unable to walk without a brace and cane. This patient is shown as an example of over-treatment. The second manipulation forced the fragments out of apposition.



a



b

Fig 17 Case 48 E S a housewife of 50 years who sustained a fracture of the neck of the right femur without displacement. It was manipulated and a plaster-of-Paris spica was applied and kept on for 94 days. Follow up examination 3½ years after injury shows very slight shortening. Her hip has only 10 to 15 degrees of motion. She has no pain and very little limp. The roentgenograms show a fracture without displacement which in reduction was forced into extreme internal rotation and the end result is a united fracture with very marked degenerative changes in the femoral head. This fracture should have attained a perfect result if there had been no forcible manipulation. Protection was all that it required.

fairly well and enjoy a certain amount of normal activity, while 13 or 65 per cent, are unable to walk without support, and some of these are practically bedridden.

Patients with non union almost invariably showed motion limited in all directions at the hip and to a slightly lesser degree at the knee joint. The disability attendant on non union is very real and distressing in spite of the occasional case which is almost symptomless. Only the symptomless cases are able to report to clinics to be seen.

The 15 known private patients are similarly summarized in Table II.

The reason for the higher percentage of union among the private patients than among the entire group is purely fortuitous. Five of the 9 patients with union had no original displacement and only one of these was displaced by manipulation.

TABLE II — PRIVATE PATIENTS

	Number	Union		Non union	
		Number	Per cent	Number	Per cent
Total known	15	9	60	6	40
Total living	3	3	100	0	0
Total dead	2	2	100	0	0

Factors concerned in union of the fracture. In attempting to analyze certain factors which, in our series, seem to have had a definite bearing on union of the fracture we present the following discussion.

1. Method of treatment. Those patients treated with plaster of Paris spica, after manipulation, in most instances showed a percentage of union equal to that of the entire group.

Traction, although employed in a very limited number of patients, has been the least successful and has, we believe, no place as the principal treatment in fractures of the neck of the femur.

Those patients who had no immobilization or only sandbags showed the highest percentage of union. These were with one exception patients who showed no original displacement of the fracture. This merely serves again to emphasize the

TABLE III — TREATMENT IN RELATION TO UNION

	Total number of cases	Union of fracture	Per cent
Reduction and plaster of Paris	38	24	63
Traction	5	3	60
No immobilization or sandbags	5	4	80

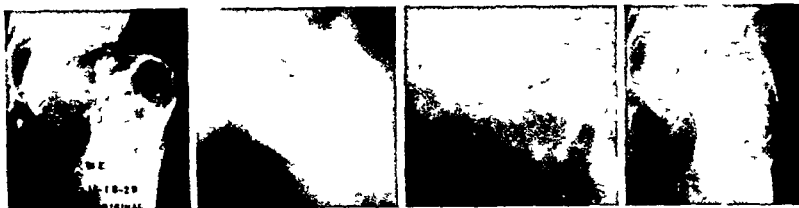


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Fig. 20 Case 2 J. T. a merchant 67 years of age with a fracture of the neck of the left femur with original displacement. Two attempts were made to reduce this, both completely unsuccessful as shown by the roentgenograms. He was kept in plaster of Paris spica for nearly 3 months

The end result was non union with $3\frac{1}{2}$ inches of shortening, marked limp and pain on weight bearing, though the patient is able to walk with a cane. This case is shown as an example typical of failure to obtain reduction of the fracture.

for derotation of the head fragment have been watched for.

Rotation of the head in this discussion shall be considered to be about an axis passing through the center of the articular surface of the head and emerging from the center of the fractured surface thereof (Fig. 2). When present it is always with the rotation in an upward direction anteriorly. In the undisplaced incomplete and fragmented fractures, as will be seen, the mechanics causing this rotation is not in force. In the usual occurrence of fracture of the neck of the femur the posterior cortex of the neck gives way, the fracture opens above and in front (Fig. 4) and the outer or trochanteric fragment rotates forward due to the pull of the gluteus maximus and short rotator muscles (Fig. 5). At the same time that the distal fragment travels forward it also moves upward due to the pull of the long muscles of the thigh and to weight bearing if the patient is in an erect position (Fig. 6). As it travels upward the thigh becomes adducted due to the pull of the adductor muscles, the relaxation of the gluteus medius muscle and the weight of the pelvis. Many of these fractures occur from indirect vio-

lence while the patient is erect, the head of the femur being actually twisted off and the patient then falling. Taking this mechanical situation into consideration, it can be seen that the lower portion of the head and neck remains in contact longest and that, as the spicules of these fragments mesh, the lower part of the head will be carried forward with the neck and then upward in an arc of rotation, the head turning about the axis as given above (Fig. 3). Rotation has been noted in numerous cases at open operation and has been found to be present up to 160 degrees. Once it has occurred, no form of closed manipulation can derotate the head so that its spicules will exactly match those of the neck, for as the thigh is flexed the head will turn farther upward maintaining its relation of abnormal rotation with the neck.

The importance of rotation of the head lies in the fact that even though end to end position of fractured surfaces be secured, the spiculation of the fragments will prevent close apposition of the fracture surfaces and several unsatisfactory conditions result. These are cited in the following paragraphs.



Fig. 21 Case 47 L. A. an unemployed mendicant who usually used a crutch owing to an amputation of the left leg. At the time of his accident he was wearing an artificial leg on his left stump and he fell and broke the left hip. The reduction shows end-to-end apposition in the anteroposterior and lateral views, but the spicules did not match owing to the failure to remove the rotation of the femoral

head, and 1 year later there was no evidence of bony union but the head followed the neck in a flexion and abduction so there must be fibrous union. If this can be said to exist. This case is presented as an example of end-to-end apposition which failed to unite owing to rotation of the femoral head and perhaps to the presence of interposed soft tissue.



Fig 22 Case 11, B B, a woman of 57 years of age, who fractured the neck of the left femur. The original roentgenogram was interpreted as showing no displacement. She was merely immobilized with sandbags for 105 days. A recheck of these roentgenograms shows absolutely definite displacement originally and progression to non-union. This patient is pretty completely incapacitated owing to the ununited fracture, an old Pott's disease, and arthritis. This is an illustration of inability or failure to interpret correctly the original roentgenograms.

1. If the rotation is above 90 degrees, the shape of the head in its misplaced position at the upper margin may prevent satisfactory abduction of the thigh even though excellent union is secured (Fig 7b).

2. An abnormal amount of blood clot will form between the fragment ends, and this in itself is an excellent cause of non-union, as it is in any fracture (Fig 7c).

3. True anatomical position of the head on the neck is frequently impossible to secure, some degree of angulation being present (Fig 8).

4. The holding apart of the fractured surfaces by the mismatched spiculations will cause undue tautness of the capsular and ligamentous structures surrounding the fracture site, and this tension may well be in itself a cause of arterial obstruction, decreasing the vascular supply to the neck fragment.

Rotation of the head fragment can always be assumed to exist except in incomplete, comminuted, and undisplaced fractures. It can be determined by x-rays, if carefully looked for, by the following points: (1) a mismatching of position of the gross spiculations of fragments, either in flat or stereoscopic views (Figs 7a and 9), (2) angulation of the fragments following closed or open reduction (Fig 8), (3) by abnormal contour of the upper surface of the head fragment.

Rotation, as has been described, when it is present, will always be in an upward direction of the head fragment anteriorly, no case having been seen with rotation in the opposite direction. We have studied the roentgenograms of every patient in this series with rotation of the femoral head in mind and have arrived at the conclusion that this

type of displacement should be determined in every fracture of the neck of the femur before instituting treatment.

If rotation is found, it would seem advisable to open the joint capsule, derotate the head, and match the spiculations in cases in which any form of reduction is considered. Percussion impaction of mismatched spicules is illogical, as it destroys anchoring irregularities of surfaces and creates additional trauma.

Locking spicules make derotation difficult even with the hip widely exposed, and with closed reduction it is often impossible. Derotation of the femoral head has not always been successful, and in the cases in which failure to secure perfect apposition is encountered, fragmentation has been found to be originally present or other previous attempts at reduction have destroyed the spiculation usually present and have caused fragmentation to exist.

4. *Fractures that suffer from overtreatment.* Too wide abduction, too much internal rotation will pull the fractured surfaces apart. There have been several instances with a good original reduction which has not pleased the surgeon, and a second attempt has resulted in displacement.

5. *Incorrect interpretation of roentgenograms.* Failure to immobilize a fracture which was considered undisplaced resulted in further displacement and non-union in two instances. This is due to an incorrect interpretation of roentgenograms.

6. There have been several instances of adequate reduction of the fracture, firmly held for a sufficient length of time, which have gone on to non-union. When the femoral head shows increasing density signifying death of bone, the

problem is that of blood supply. Since we have been reducing these fractures by open operation we have found not infrequently, interposed capsule or articular cartilage between the fractured surfaces, and we believe that this is an important cause of non union.

7 *Unreadable roentgenograms* In two instances the chance of union was gambled on post reduction roentgenograms which were impossible to read. Both patients had non union and one died 7 months after her injury. This fault has been remedied and has not been noted during past 5 years.

SUMMARY

A group of 50 elderly patients 78 per cent women, with fractures of the neck of the femur is presented. They have been treated conservatively and the length of their hospital stay and the expense incident to it is discussed. The immediate mortality was 14 per cent. There were 19 of 48 who had bony union of their fracture. According to the way it is figured, this varies between 38 and 46.5 per cent of the series. Two thirds of the patients with non union had serious disability. Factors which played a part in union are discussed. Emphasis is placed on rotation of femoral head.

REASONS FOR STUDY

This report is the result of dissatisfaction on the part of the surgical and orthopedic services of

St. Luke's Hospital with methods of treatment which offer less than 50 per cent chance of union. We realize that the problem is not altogether one of methods, however. The average age of these patients and the deficient blood supply at the fracture site will probably always insure a fairly high percentage of failures. The authors have come to the conclusion that the chances of getting union with a useful hip may be greatly enhanced by open reduction, derotation of the femoral head where rotation exists and internal fixation if surgery can be employed with no greater immediate mortality than this series shows, that is 14 per cent. If these results can be improved upon or only equaled by a method which secures complete reduction and fixation and shortens the hospital stay from 122 days to 30 or 40 days at the outside, with corresponding reduction in expense to patient and hospital such a method is bound to be adopted.

The end results obtained in this series of patients are such that open reduction and internal fixation should insure greater chance of bony union. It can scarcely result in less. However, until we can report a similar series, treated by open reduction and internal fixation and followed for a similar period of time with known end results in at least 95 per cent of the patients, expressions of opinion about improved results are merely idle surmise.

ASEPTIC URETERO-INTESTINAL ANASTOMOSIS

JAMES I FARRELL, M D , F A.C.S , and YALE LYMAN, B S , Evanston, Illinois

IT HAS been definitely established that uretero-intestinal anastomosis is clinically applicable in the human. Many advances have been made in recent years, and successful results have been obtained. Most of the present methods, however, are technically difficult, and require the use of catheters, cautery, and special preparation of the bowel.

Coffey (1) in 1930 introduced a rather simple technique of uretero-intestinal anastomosis. By this method a suture was placed through the ureter and bowel, tied securely, and allowed to slough through into the bowel. The resultant opening made by the slough of ureteral wall and bowel wall is the ureteral stoma into the bowel.

In 1932, Coffey (2) modified this procedure by placing in the rectum a metal ring to which the transfixion suture was anchored. This assures a penetration of the intestinal lumen and makes for more certain and rapid cutting through of the suture by means of traction on a string tied to the ring leading down to the anus.

Higgins in 1933 presented a similar method in which simultaneous transplantation of both ureters into the bowel was done at one sitting. Briefly, the principle of the sloughing suture was used. The ureters remained attached to the bladder after the first operation. At a later date the ureters were to be divided and ligated between the ureteral implantation and the bladder.

Hinman in 1933 proposed an extraperitoneal ureterostomy for drainage of urine until such time as the suture cut through to establish a new orifice.

Ferguson and Path used a cautery to make the opening between the ureter and bowel.

Wodhaus and Carobba in 1935 obtained an apparently successful opening in one dog by coagulation of ureteral and intestinal surfaces in apposition. Following the coagulation the ureter was placed in apposition with the coagulated surface of the bowel, the ureter being transplanted in the bowel musculature.

The author, having performed an operation known as the Eck fistula operation (3), decided to apply the principle of this operation to the implantation of the ureter into the bowel. An Eck fistula is an anastomosis of the portal vein and the inferior vena cava, in which no opening is made

in these structures until they are firmly united. The opening is later made by means of a cutting loop of strong silk thread. The patency of the new opening is maintained by forcing all the blood through the new opening. The maintenance of the opening is very necessary, as these artificial openings tend to close spontaneously.

PROCEDURE

A portion of the sigmoid is grasped between two Allis clamps and an incision is made longitudinally in the serosa. The longitudinal muscle of the bowel is separated until the circular muscle is exposed. The circular muscle is not cut, but is separated from the submucosa (Fig. 1, A) at the lowermost portion of the incision. The submucosa is then grasped with a small mosquito forceps and brought out through the opening made in the circular muscle (Fig. 1, A). The ureter is approximated to the submucosa by a continuous suture of No. 00 chromic catgut. A small vein clamp is placed on the ureter above the site of anastomosis (Fig. 1, B). A curved needle with black silk thread pierces the ureteral lumen and emerges about 1 centimeter distally. This same curved needle enters the lumen of the bowel and emerges from the bowel opposite its insertion into the ureter (Fig. 1, C). A second suture of catgut is used to approximate the ureter to the bowel (Fig. 1, D). The silk thread is now used to make the opening between the ureter and bowel. This is done by a sawing motion with the thread. When the thread is removed, a second suture line is placed along the point of the ureterosigmoidal junction (Fig. 1, E).

A clamp is now placed on the ureter between the site of anastomosis and the bladder, if any point of leakage occurs it can be seen and closed. The ureter is ligated and cut. The cut end of the ureter is then buried in the bowel wall between the submucosa and the circular muscle (Fig. 1, F). No attempt is made to close the circular muscle since it forms a sphincter at entrance of ureter into the bowel. The longitudinal muscle is approximated with sutures over the ureter (Fig. 1, E).

The resulting anastomosis is completed in one operation. Urine appears in the bowel almost immediately. The ureter is securely anchored to the submucosa thereby preventing it from becoming

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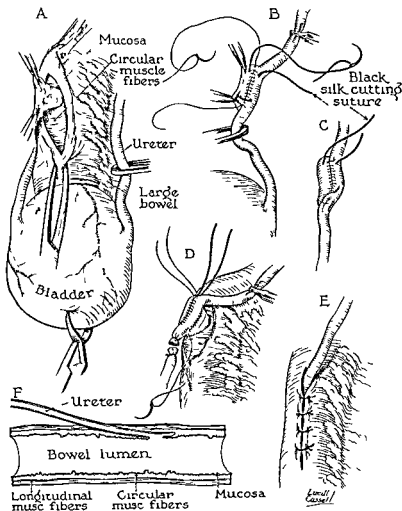


Fig 1 Technique of operative procedure

detached. Side to-side anastomosis allows for a large longitudinal opening in the ureter, which prevents a contraction of its orifice. The circular muscle of the bowel surrounds the intramural portion of the ureter thereby forming a closure mechanism which prevents regurgitation of intestinal contents into the ureter. Because of the ease of doing a side to-side anastomosis a water tight anastomosis is made. This is most important because a leak from the bowel usually causes a fatal peritonitis. It is much safer to do this type of anastomosis than to insert the end of the ureter through an opening in the bowel. Leakage is more likely to occur when the ureter is inserted into the bowel.

EXPERIMENTAL DATA

Seven dogs had an anastomosis of both ureters and the sigmoid. These dogs were allowed to survive for 6 months then 4 of the animals were sacrificed to study the end results. One dog died at end of 4 months and autopsy was performed. Two dogs are alive and well after an 8 month period.

Gross findings. Figure 2a autopsy specimens of the kidneys, ureter and bowel of the sacrificed dogs. Figure 2a shows the specimen of the dog which died with an ascending urinary infection. We attribute the cause of infection to implanting the ureter too close to the kidney. In our experiments it is best to transplant the lower third of the ureter rather than the higher third.

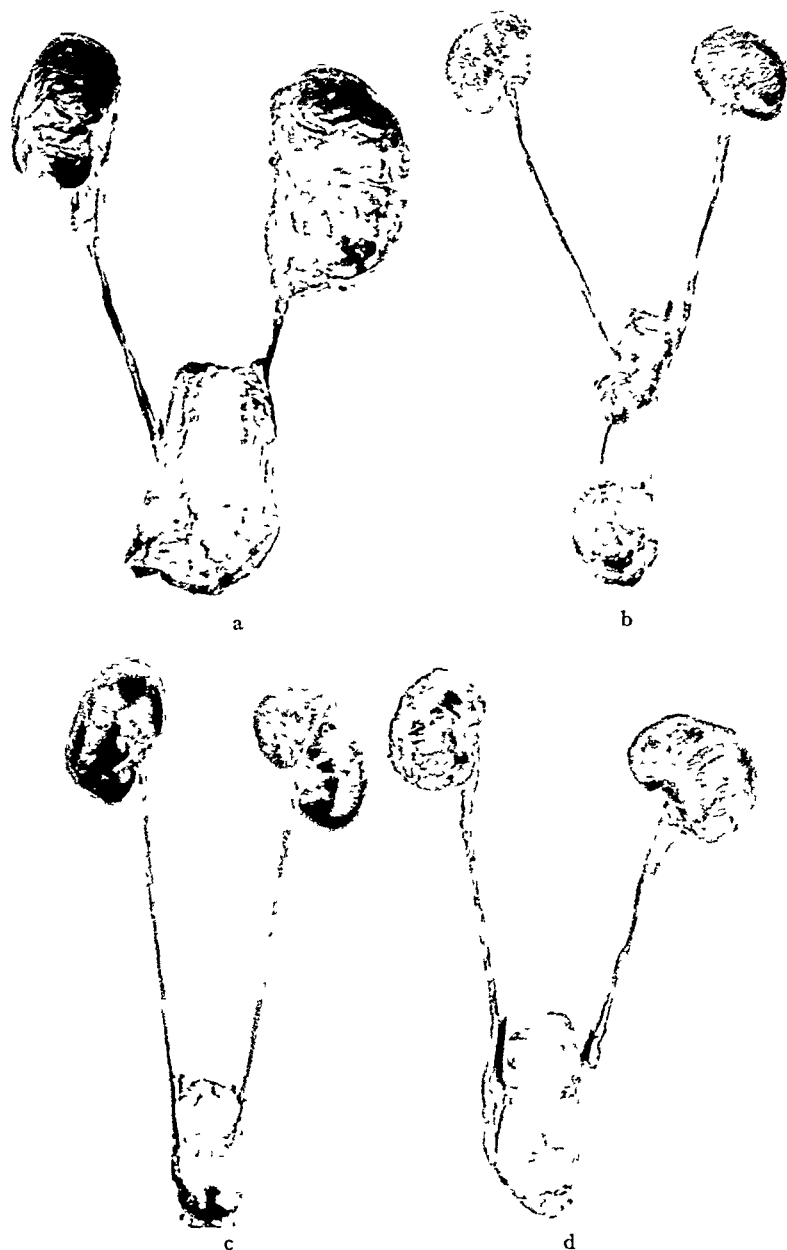


Fig 2 Autopsy specimens of kidneys, ureters and bowel of dogs

Figure 2b shows an autopsy specimen of ureteral transplantation by the Higgins method. The ureters still open into the bladder. This dog passed urine per rectum for about 6 weeks; the stool then became firmer in consistency, and the dog began to void through the urethra. When the

dog was sacrificed later, the stoma between the ureter and the bowel was completely closed. Figure 3b shows the bladder distended with sodium iodide; the ureters and kidney pelvises are also filled with sodium iodide. But no iodide is found in the bowel. This serves to illustrate the danger

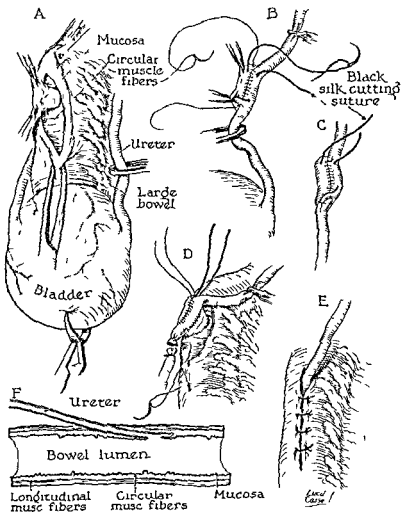


Fig 1 Technique of operative procedure

detached. Side to side anastomosis allows for a large longitudinal opening in the ureter which prevents a contraction of its orifice. The circular muscle of the bowel surrounds the intramural portion of the ureter thereby forming a closure mechanism which prevents regurgitation of intestinal contents into the ureter. Because of the ease of doing a side to side anastomosis a water tight anastomosis is made. This is most important because a leak from the bowel usually causes a fatal peritonitis. It is much safer to do this type of anastomosis than to insert the end of the ureter through an opening in the bowel. Leakage is more likely to occur when the ureter is inserted into the bowel.

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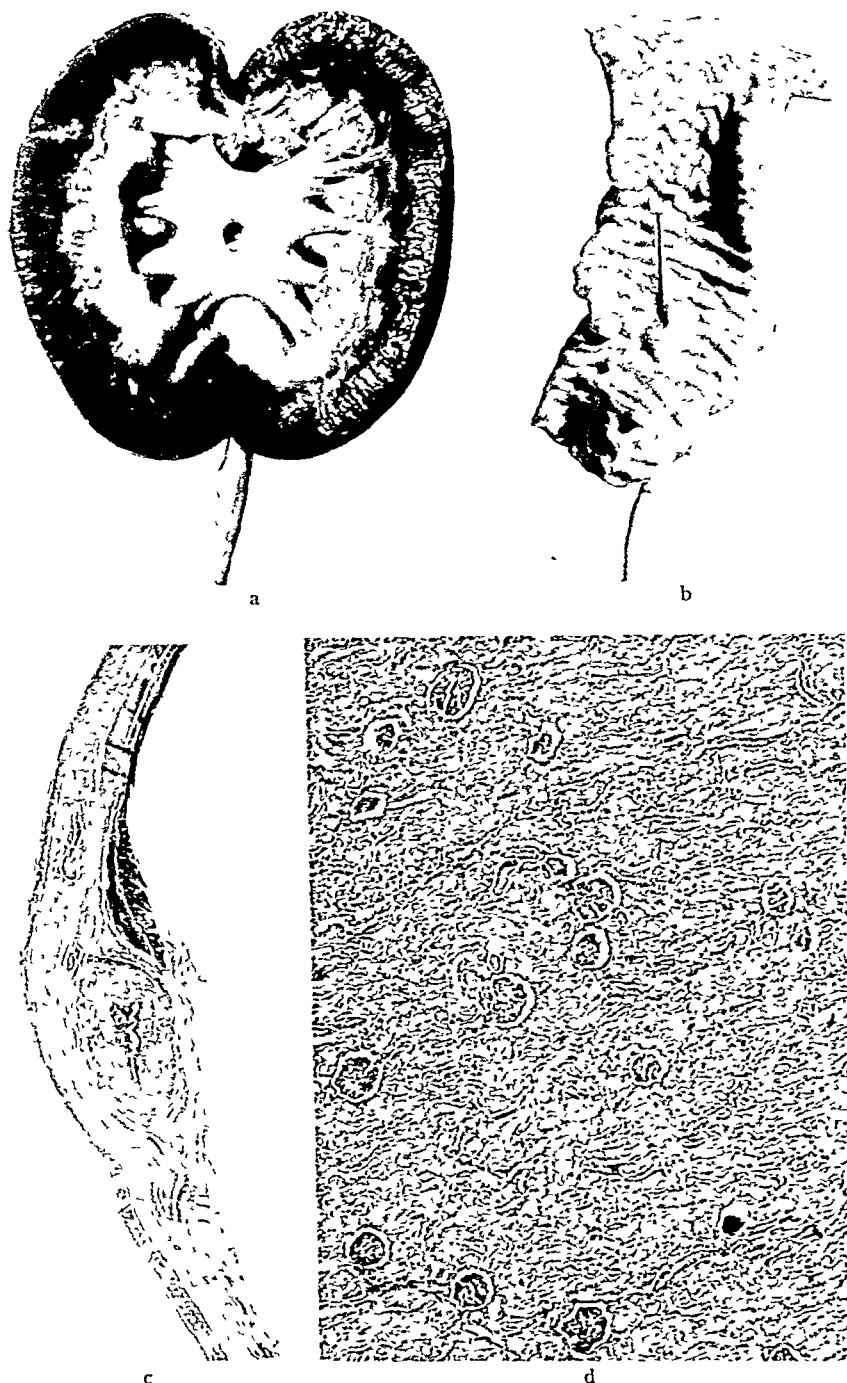


Fig 4 a, kidney 6 months after implantation, b, specimen shows ureteral opening, c, lower power photomicrograph of ureter after implantation, d, microscopic section of kidney 6 months after uretero-intestinal anastomosis.

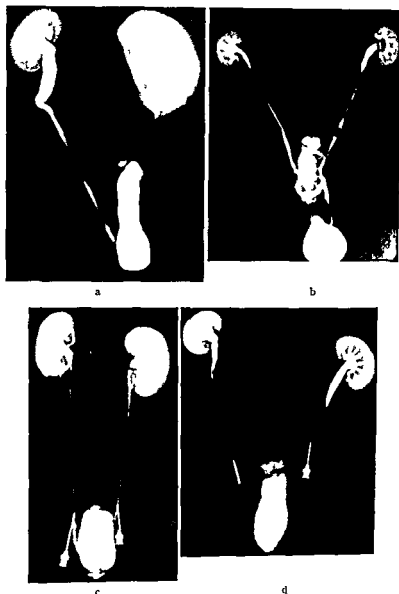


Fig 3 Roentgenograms with bladder distended with sodium iodide

of closure when the ureterosigmoidal opening is made by the sloughing suture. Unless the ureter is divided between the ureter and bowel the urine tends to follow its normal course. And likewise an incision into the unoccluded ureter tends to close. In ureterolithotomy the ureter closes without the use of suture material.

Figures 2c and d show the autopsy specimens of 2 dogs 6 months after implantation of the

ureters by our method. Both kidneys appear healthy and the roentgenograms Figures 3c and d show a normal ureter and renal pelvis.

Figure 4a shows one of the kidneys 6 months after implantation. There is no evidence of infection, or dilatation from the long transplantation. Figure 4b was taken to show the ureteral opening in the bowel. The rectal mucosa is clean and pink with no evidence of irritation or infection after 6

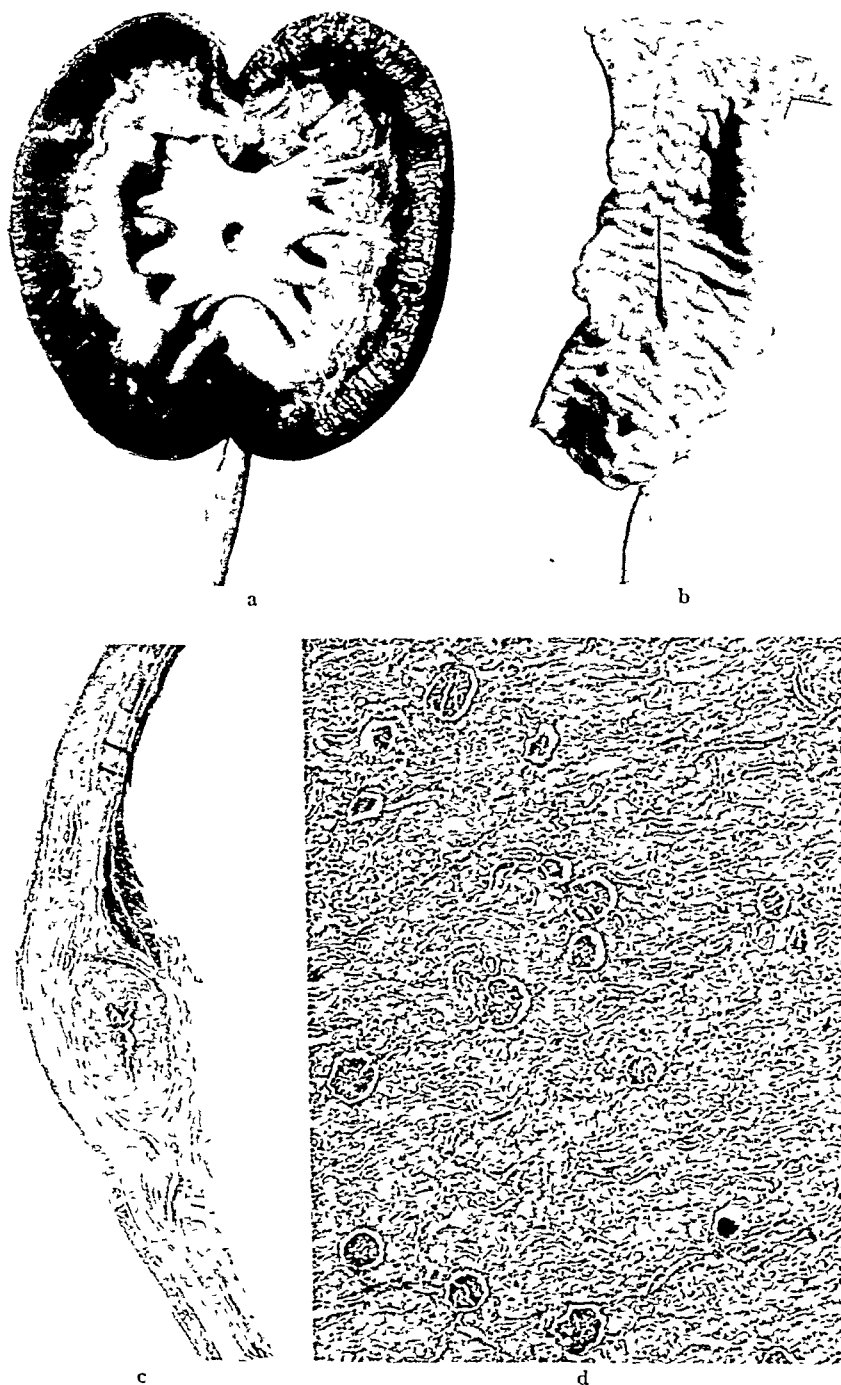


Fig 4 a, kidney 6 months after implantation, b, specimen shows ureteral opening, c, lower power photomicrograph of ureter after implantation, d microscopic section of kidney 6 months after uretero-intestinal anastomosis

months constant contact with urine. Figure 4c is a low power microscopic view of the ureter after implantation in the bowel. Figure 4d is a microscopic section of a kidney 6 months after uretero-intestinal anastomosis.

Microscopic examination. Examination of the ureter as it passes through the bowel was made. There was no evidence of infection at the site of anastomosis; the ureter was in no way narrowed, and the musculature of the bowel closely surrounded the ureter (Fig. 4).

ADVANTAGES OF TECHNIQUE

The transplantation of the ureters into the bowel is a physiological problem in which one must adhere to fundamental principles. First if an anastomosis is to be done between the ureter and sigmoid, it must be an airtight and water tight anastomosis. The escape of urine, fecal material or gas into the peritoneum after the completion of the operation is certain to cause peritonitis. The method of transplantation, described as the side-to-side type, makes it possible to test the anastomosis after its completion.

Second, the maintenance of the original size of the ureteral opening into the bowel is important. Stricture of the ureter following transplantation is often due to the large number of sutures taken in the circumference of the ureter. This is obviated in our operation by the suture of the side of the ureter to the side of the bowel instead of implanting the cut end of the ureter. In the Higgins technique the ureterosigmoidal opening closes spontaneously, if the ureter remains connected with the bladder over a period of 6 to 8 weeks.

In attempting to construct a valve like action at the site of anastomosis we have cut no muscle in the bowel wall. The ureter is transplanted so that it traverses the longitudinal and circular muscle layers of the bowel and ends just beneath the mucosa of the bowel lumen. The ureter does not project into the lumen of the bowel. We feel that this is a factor in preventing postoperative blocking of the ureter during the healing process.

Anastomosis of the ureter and sigmoid without opening either structure in the peritoneal cavity certainly tends to prevent peritonitis which is a danger in other procedures. The use of the sawing ligature in blood vessel surgery has long been known. We feel that its use in ureterosigmoidal anastomosis is worthwhile.

SUMMARY AND CONCLUSION

An improved technique is presented for uretero-intestinal anastomosis. This method has several advantages over previous procedures. No cathe-

ters, cautery or bowel preparation is necessary in the technique. The ureter and the bowel mucosa are firmly united before the opening is made. Neither the ureter nor bowel is opened directly into the peritoneal cavity. The bowel musculature is not cut but is separated from the submucosa by blunt dissection. We believe that this preserves and maintains the musculature. Implantation of the ureter between bands of circular muscle helps to form a competent sphincter like mechanism.

A long longitudinal opening, about 1 to 2 centimeters is made between the ureter and the bowel. This size opening is more than adequate and allows for a reasonable amount of contraction.

The ureter between the anastomosis and the bladder is divided at the time the anastomosis is made. This forces the urine to flow through the new anastomosis immediately. We believe that this is an important factor in maintaining the caliber of the anastomosis. A study of ureteral physiology and surgery impresses one that an opening made in the unoccluded ureter tends to close rapidly. In ureteral lithotomy there may be no drainage of urine from the ureteral opening after the second or third day. We have demonstrated that the anastomosis made by the Higgins method will close completely in 6 to 8 weeks. In all likelihood the contraction and closure of this opening is a rather rapid process.

A group of old principles of blood vessel anastomosis are applied to uretero-intestinal anastomosis. Seven dogs had survived 6 months following this procedure and autopsy studies were made.

Roentgenograms of the autopsied specimens were made to show the results.

The closure of the anastomosis made by the sloughing suture is emphasized.

Microscopic studies show the implanted ureter in the bowel wall.

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SPURS OF THE OS CALCIS

ARTHUR STEINDLER, M D , F A C S , and ALBERT R. SMITH, M.D., Iowa City, Iowa

THE association of painful heels with calcaneal spurs is comparatively recent. Plettner, in 1900, first discovered the spurs—quite by accident¹ Increasingly widespread use of the X-ray has shown that remarkably few such spurs give rise to symptoms² In those individuals who do have pain in the heel associated with a spur of the tuber of the os calcis, avoidance of weight bearing affords relief from the painful symptoms. The following study was undertaken with the view of ascertaining the permanency of relief obtained by such simple measures in comparison with the results of operative therapy.

In this investigation only those cases of painful heel in which the existence of a calcaneal spur is demonstrable roentgenographically have been used In all cases, both those treated conservatively and those treated operatively, the spur was on the plantar surface of the bone.

THE CONSERVATIVE TREATMENT

The number of patients treated conservatively was 49,³ of which 27 had unilateral and 22 bilateral defects Thus there is a total of 71 painful heels associated with calcaneal spur in the series. The age of these patients was 18 to 75 years at the

time treatment was instituted, the average was 41 8 years Trauma other than walking was of possible etiological significance in 9 heels in the series Gonorrheal urethritis was known to antedate the onset of symptoms in only 2 instances

In all cases the conservative treatment consisted of an insole, either felt or solid leather, with a hole cut out over the point of the spur. Occasionally a soft rubber sponge was applied over this area. In addition to these measures in 28 feet a posterior wedge in the heel of the shoe was used in order further to relieve the tuber of the os calcis from weight bearing stress. The results are shown in Table I.

In compiling the data given in Table I it was noticed also that in the bilateral cases with treatment by insoles alone patients were required to wear their shoe corrections for more than 1 year in all but 2 cases In the unilateral cases, on the other hand, patients were able to discard all appliances in an average of 8 months The longest time that corrections were worn by a patient with a unilateral defect was 19 months

Thus we see that the painful symptoms were controlled by conservative measures in 46 4 per cent of the feet involved

THE OPERATIVE TREATMENT

In this group there are 10 patients with a calcaneal spur and symptoms unilaterally and 6 patients with both feet affected, making a total

¹Quoted from Sack.
²Sack (2) reports that 43 per cent of the spurs of the os calcis give rise to no symptoms

³In addition to these there are 47 patients with painful heel associated with spur of the os calcis which are not included either because of insufficient observation period or because the results of therapy are unknown

TABLE I—RESULTS OF THE CONSERVATIVE TREATMENT OF SPURS OF THE OS CALCIS—71 FEET

Group	Total No. of feet in group	Time shoe corrections were worn	Results	Observation period average in yrs	No. of feet ultimately requiring operation
I Insole only	36	2 wks to 4 yrs, average 10 4 mos	16 or 44 4 per cent complete* and permanent relief 20 or 55 5 per cent slight or no relief †	3 8 0 83	None 13 after an average of 9 mos conservative therapy
II Insole and Steindler heel	35	1 mo to 2 yrs average 7 3 mos	17 or 48 5 per cent complete and permanent relief 18 or 51 4 per cent slight or no relief ‡	2 96	None 9 after an average of 1 mos conservative therapy
Total	71	average 8 8 mos	33 or 46 4 per cent complete and permanent relief 38 or 53 5 per cent slight or no relief	2 1 for entire series	22 or 30 9 per cent

*Two of these feet were operated upon previously elsewhere without relief and with recurrence of both symptoms and calcaneal spur Corrections were worn for 4 years Now observed for 6½ years Have had complete relief during these 6½ years

†Two of these were completely and permanently relieved after 2 weeks in plaster casts

‡Two of these subsided spontaneously and have been painless for 5 years The corrections were worn for 6 months without apparent benefit. Symptoms subsided 1 year later

months constant contact with urine. Figure 4c is a low power microscopic view of the ureter after implantation in the bowel. Figure 4d is a microscopic section of a kidney 6 months after uretero-intestinal anastomosis.

Microscopic examination. Examination of the ureter as it passes through the bowel was made. There was no evidence of infection at the site of anastomosis; the ureter was in no way narrowed and the musculature of the bowel closely surrounded the ureter (Fig. 4).

ADVANTAGES OF TECHNIQUE

The transplantation of the ureters into the bowel is a physiological problem, in which one must adhere to fundamental principles. First, if an anastomosis is to be done between the ureter and sigmoid it must be an airtight and water tight anastomosis. The escape of urine fecal material or gas into the peritoneum, after the completion of the operation, is certain to cause peritonitis. The method of transplantation, described as the side-to-side type, makes it possible to test the anastomosis after its completion.

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In attempting to construct a valve like action at the site of anastomosis we have cut no muscle in the bowel wall. The ureter is transplanted so that it traverses the longitudinal and circular muscle layers of the bowel and ends just beneath the mucosa of the bowel lumen. The ureter does not project into the lumen of the bowel. We feel that this is a factor in preventing postoperative blocking of the ureter during the healing process.

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An improved technique is presented for uretero-intestinal anastomosis. This method has several advantages over previous procedures. No cathe-

ters, cautery, or bowel preparation is necessary in the technique. The ureter and the bowel mucosa are firmly united before the opening is made. Neither the ureter nor bowel is opened directly into the peritoneal cavity. The bowel musculature is not cut but is separated from the submucosa by blunt dissection. We believe that this preserves and maintains the musculature. Implantation of the ureter between bands of circular muscle helps to form a competent sphincter like mechanism.

A long longitudinal opening, about 1 to 2 centimeters, is made between the ureter and the bowel. This size opening is more than adequate and allows for a reasonable amount of contraction.

The ureter between the anastomosis and the bladder is divided at the time the anastomosis is made. This forces the urine to flow through the new anastomosis immediately. We believe that this is an important factor in maintaining the caliber of the anastomosis. A study of ureteral physiology and surgery impresses one that an opening made in the unoccluded ureter tends to close rapidly. In ureteral lithotomy there may be no drainage of urine from the ureteral opening after the second or third day. We have demonstrated that the anastomosis made by the Higgins method will close completely in 6 to 8 weeks. In all likelihood the contraction and closure of this opening is a rather rapid process.

A group of old principles of blood vessel anastomosis are applied to uretero-intestinal anastomosis. Seven dogs had survived 6 months following this procedure and autopsy studies were made.

Roentgenograms of the autopsy specimens were made to show the results.

The closure of the anastomosis made by the sloughing suture is emphasized.

Microscopic studies show the implanted ureter in the bowel wall.

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by rotating the posterior portion of the os calcis in such a manner that the spur comes to lie in the horizontal plane and not in a vertical or oblique plane. The operation is performed as follows.

A curved incision, starting on the lateral aspect of the foot one inch above the insertion of the tendo achillis, is made. The incision follows the tendo achillis and then curves anteriorly and inferiorly, ending at the lateral margin of the sole, anterior to the tuber of the os calcis. The calcaneus is then exposed, the periosteum stripped away, thus exposing the entire posterior and inferior portion of the os calcis. When this is done, a curved osteotomy through the os calcis is performed. The line of the osteotomy passes from a point anterior to the insertion of the tendo achillis to a point just anterior to the insertion of the plantar fascia at the tuber. The plane of the osteotomy is at right angles to the lateral surface of the os calcis (Fig. 1).

A wedge is then removed from the inferior surface of the anterior portion of the os calcis (Fig. 2).

The tendo achillis is then lengthened, following which the posterior portion of the os calcis, carrying the spur with it, is rotated anteriorly and superiorly into its new position. The two portions of the os calcis are fixed in their new relation with an ivory bone peg or steel pin. This brings the spur into the horizontal plane (Fig. 3).

CONCLUSIONS

1 Approximately half of the cases of painful heel with spur of the os calcis may be controlled symptomatically by conservative measures.

2 If conservative measures fail, then operative removal of the spur is indicated.

3 If simple excision of the spur is followed by recurrence of both the spur and the symptoms, the rotation osteotomy is indicated. This, however, is a radical procedure and not without danger.

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Fig. 1 Curved incision lateral aspect of foot 1 inch above insertion of tendo achillis



Fig. 2 A wedge is removed from the inferior surface of the anterior portion of the os calcis



Fig. 3 New relation of two portions of os calcis which is maintained with ivory bone peg, or steel pin

of 22 feet. Eighteen of these feet are among those in which conservative measures failed to control the symptoms. One of the two types of conservative treatment was used for 1 week to 2 years before operation in these 18. In addition a brace was worn by 2 of these patients without ameliorating their symptoms before operation. Four feet were operated upon without the previous use of conservative measures. In all but one patient (a unilateral case) one of the two types of conservative therapy was instituted for a varying length of time after operation. Two types of operation were performed. A simple excision of the spur through a medial incision such as is used for a Steindler stripping was carried out in

16 instances. On 8 occasions a Steindler rotation osteotomy of the os calcis was used.* (See diagram and description of technique.) In none of the cases was the goblet incision advocated by Miltner used. The results are shown in Table II.

Comparison of the tables shows that approximately the same proportion of the patients had their symptoms controlled by conservative measures as by simple excision alone. In comparison of the totals of the operative and conservative groups we find an insignificant difference in the percentage relieved from distress. As stated all those operated upon were (with 4 exceptions) given a trial on the conservative regimen. *Failure of the conservative treatment formed the basis for the operative indication.* The rotation osteotomy is too radical a procedure to be used in any but the most recalcitrant type of case.

THE STEINDLER ROTATION OSTEOTOMY OF THE OS CALCIS

This operation is designed to take all weight bearing off the point of the spur. It achieves this

*Two of these cases, which recurrence of spur and pain followed simple excision.

Two of the group that recalcitrant to treatment with conservative measures, failed to respond to the conservative treatment. One of these patients had both feet affected and in the same patient in which a simple excision failed to effect any relief bilaterally.

TABLE II—RESULTS OF THE OPERATIVE TREATMENT OF SPURS OF THE OS CALCIS—22 FEET

Type of operation	No. of feet operated upon	Result	Postoperative observation period	Recurrence of pain (No. of feet)
Simple excision	16	70.63 per cent complete and permanent relief 9 or 56.2 per cent slight or no relief	1 mo to 3 yrs aver 17 mos	8 or 50 per cent
Rotation osteotomy of os calcis	8	6 or 75 per cent complete and permanent relief 2 or 25 per cent slight or no relief	6 mos to 3 yrs 8 mos aver 24 mos	3 or 37.5 per cent
Total	24	50 or 62.5 per cent complete and permanent relief 9 or 40 per cent slight or no relief	1 mo to 3 yrs 8 mos aver 22 mos 25 mos	11 or 45.8 per cent

*Two of these represent failure of simple excision. They are included but once in the total where they appear among those having complete and permanent relief. The figures appearing in the total of the table represent the final proportion of feet relieved of pain and in which the symptoms were not controlled.

One of these had a postoperative osteomyelitis of the os calcis which necessitated amputation of the foot 3 years after the osteotomy. The foot is painful and function is excellent. The individual had both feet affected and in the same patient in which a simple excision failed to effect any relief bilaterally.



Fig 1 Specimen No 22, 1937 Chronic erosive antrum gastritis. Pronounced round cell infiltration into the hypertrophic stomach wall. Hyperplasia of the lymphoid follicles. Superficial erosions, \times ; marked edema between muscularis mucosae and muscularis propria. $\times 18$



Fig 2 Specimen No 22, 1937 Erosive hemorrhagic antrum gastritis. Deep erosion (left), mucosa surrounding the erosion is infiltrated with round cells, inflammatory exudate and red cells, profuse hemorrhage between mucosa and muscularis mucosae (right). $\times 18$

Puhl interested in pathological anatomy, and knowing how to prepare tissues obtained by gastric resection, were the first to explore the histological genesis of gastritis. Gastroscopic studies advanced by Schindler (21, 22); Henning, Moutier, Swalm, Jackson, Morrison, and others, and an improved x-ray technique, helped to clarify this disease.

Gastritis (simplex) appears in two forms—the acute and the chronic. Acute gastritis is either a so-called irritation gastritis with round cell infiltration of the stomach wall and profuse discharge of mucus, or, it is hemorrhagic, as an attendant of acute infectious diseases. Chronic gastritis is either hypertrophic, usually limited to the antrum and accompanied by erosions and ulcers or is atrophic, usually involving the entire stomach. It has been shown, however, (Faber, 9, Konjetzny, 13) that the hypertrophic antrum gastritis may finally change into an atrophic antrum gastritis.

It is the chronic hypertrophic gastritis, associated with erosions and acute ulcers that is the usual companion of peptic ulcers in Central Europe, and which, as it is said, is uncommon in the United States. It is well understood in this country why the conservative methods of operation have been abandoned in Central Europe as not being satisfactory: the stoma made at pyloroplasty or gastro-enterostomy in gastritis cases

must be placed directly in the involved region of the stomach. Since hypertrophic erosive gastritis usually is limited to the antrum, subtotal gastric resection, as surgical treatment for peptic ulcer, offers more chances of permanent cure. In this connection, it is of interest to know that in this country, Balfour (3, 7) of the Mayo clinic, where Walters and his collaborators found a low incidence of gastritis associated with peptic ulcers, reports good results following conservative methods of operation, however, a number of surgeons in New York, where Aschner and Grossman of A. A. Berg's service, found an ulcerative gastroduodenitis in 64 per cent of 124 resected stomach specimens, report unfavorable results with the same kind of treatment (Lewisohn, and Hinton and Church).

From these reports, it is reasonable to assume that so far as peptic ulcers and gastroduodenitis are concerned, so-called geographical regions exist also in this country, but only in a few parts have examinations been made upon this important subject. For the purpose of encouraging further examinations, the result of a thorough macroscopic and microscopic examination of two resected stomach specimens might be recorded. In order to overcome autodigestion of the tissue, I put the resected specimens immediately after the resection, and while they were still body warm, into a solution of 4 per cent formalin. After 2 or 3 days, the mucous membrane was macroscopically examined with the naked eye and with the loupe. Certain places were excised

THE EXTENT AND CHARACTER OF PEPTIC ULCERS AND GASTRODUODENITIS IN DIFFERENT COUNTRIES

HANS MAY, M D, Philadelphia Pennsylvania

WITHIN the last decade, attention has been called by numerous writers to the difference in the behavior of peptic ulcers and gastroduodenitis in various countries. Walters, after returning from a visit to European clinics made a special study of this subject. His investigations brought him to the conclusion that there was a low incidence of gastritis associated with peptic ulcers in patients operated upon at the Mayo Clinic, compared with the high degree of gastritis associated with peptic ulcer cases in Central Europe. Following his publications others in this country made similar statements generally however without research proof.

I quote Walters (27) In 1930, after Snell and I had visited various surgical clinics abroad particularly those in Central Europe, we published a series of papers (25 26 29 30), describing and illustrating the difference between the lesions of duodenal ulcer, for which we saw operations performed in Germany, and those for which it has been my privilege to operate at the Mayo Clinic. This difference lay largely in the high degree of gastritis associated with duodenal ulcer of German patients operated upon at German surgical clinics as compared with the low incidence of associated gastritis in a series of patients operated upon at the Mayo clinic. Accuracy of these observations was confirmed by Sebenius, (*3, 28), of Schmiedens clinic (Frankfurt am Main) who spent several months in study at the Mayo clinic.

There is no doubt as to the truth of the findings of Walters. They are, however only valid for those regions of the country in which the observations were made. That there are certain diseases *gosters* etc (H May 16) which show a so called geomedical variation is an acknowledged fact. Since it has been proved in Europe that the lesions of peptic ulcers and gastritis also differ in various localities, and sometimes within the short distance of 100 to 200 miles it seemed reasonable to assume that such conditions could also exist in this country, with its vast extent of territory its racial and climatic differences.

From the Surgical Service B of the Lankenau Hospital Philadelphia

Presented before the Philadelphia Academy of Surgery October 5 1917

I had the opportunity to practice surgery both in regions where peptic ulcers are very rare and in places, which in medical circles are called 'ulcer regions' and I can confirm the statement that there is a difference in the behavior of peptic ulcers in various countries. While in Freiburg in Baden the number of patients treated at the University Hospital for peptic ulcers was comparatively low yet the number of such patients admitted to the University Hospital at Munich (200 miles away from Freiburg) was strikingly high nearly ten times higher than in Freiburg. Particularly high was the incidence of ulcer perforation (Buerkle De la Camp). Since I have had the privilege of doing surgical work in this country I have observed that in Philadelphia with the exception of perforations (between 7 and 11 per cent according to Eliason and Ebeling) the incidence of peptic ulcers is about as high as in Munich.

The difference in the prevalence of peptic ulcers in different localities has been variously attributed to racial characteristics different environment, and dietary habits of the population. No explanation however can be given at the present time, why duodenal ulcers compared with gastric ulcers, in some parts of the world are more common than in other parts, and why in this country and Central Europe males are more subject to the disease than females, while according to Alvarez in some other parts of the world men and women are equally affected.

A short time ago, the fact that peptic ulcers responded differently to surgical treatment in various countries was a mystery. Now more light has been thrown upon this subject since the relation between peptic ulcers and gastroduodenitis has been investigated.

The disease entity gastritis has been known for more than one hundred years but only recently has the medical profession begun to recognize its importance. Investigations were delayed by the seeming difficulty of preventing postmortem tissue autolysis of the digestive organs which sets in so rapidly. Faber of Copenhagen overcame this obstacle by injecting a 4 per cent formaldehyde solution into the stomach immediately after death. But surgeons such as Konjetzny and

were found within, either the anterior or posterior walls of the stomach. All of them, however, were situated nearer to the pylorus than to the proximal part of the stomach. In addition to these defects, several dark brown spots were discernible, either with the naked eye or the loupe. It was assumed that they were blood extravasations.

By microscopic examination, the mucous membrane of both specimens exhibited definite signs of inflammation, such as cell infiltrations into the stomach wall, chiefly into the mucosa, consisting of polymorphonuclear leucocytes and plasma cells (Fig 1). The process was accompanied by hyperplasia of the lymphoid follicles (follicular gastritis—Johnston). A marked edema separated the muscularis mucosæ from the muscularis propria. In numerous places the epithelium of the apex of the papillæ and in the depths of the crypts was breaking down, causing loss of superficial tissue, erosions (erosive gastritis), an exudate escaped from these erosions "*rauchscheidenartig*"—like a smoke screen—(Fig 1 and Fig 6). Besides these superficial erosions, other defects could be found which penetrated to the deepest layer of the mucous membrane, so that the muscularis mucosæ formed the floor of the defect (Fig 2 and following). At several places the muscularis mucosæ was found perforated. Such a picture resembles that of acute ulcer—ulcerative gastritis (Fig 5). The mucous membrane surrounding these ulcers was heavily infiltrated with round cells and inflammatory exudate. Some of these ulcers, however, had a wall rich in connective tissue which spoke for chronicity (Fig 6).

Besides these ulcers, numerous hemorrhages into the subepithelial tissue or between mucosa and muscularis mucosæ were seen—hemorrhagic gastritis (Fig 2 and following). At some places the hemorrhages were very extensive, and resembled the blood extravasations which are commonly found in acute infectious diseases (Figs 2 and 4). These hemorrhages also formed the base of many of the ulcers, and it is probable that they had been the origin of these ulcers (Fig 2 and following).

While erosions, ulcers, and hemorrhages were confined to the pyloric region, yet the round cell infiltration was also found in the proximal parts of the resected stomach specimens, definitely less, however, than in the distal part. It is unfortunate that nothing can be said as to how far the inflammation reached down below the pylorus, since the duodenum had not been removed but had been left in place.

CONCLUSION

The two specimens represented the resected antrum and a part of the fundus of the stomach in cases of inoperable duodenal ulcers. They exhibited severe pictures of chronic follicular gastritis with numerous erosions, ulcers, and hemorrhages. The 3 last named were confined to the antrum. European writers believe that the ulcers are the consequence of erosions and that the latter are due to the round cell invasion. However in these 2 cases, as described here, it must be assumed that most of the ulcers originated independently of the erosions and are due to hemorrhages. As a matter of fact, hemorrhages are uncommon findings in the European chronic hypertrophic gastritis cases.

These findings, obtained from two consecutive resections for treatment of duodenal ulcers, urge further examination. That erosive chronic gastritis is a frequent companion of peptic ulcers treated in New York City has been shown by the thorough examinations of Aschner and Grossman. The same report comes from Bloch in Chicago. Gastroscopic studies made in Philadelphia by Swalm, Jackson and Morrison, revealed chronic gastritis with or without erosions in 9 of 10 chronic peptic ulcer cases.

So it must be assumed that in some parts of this country, chronic erosive gastritis is more frequent than has been previously assumed. Which parts of the country these are, or whether, since the absence of prohibition, gastritis in general has become more frequent, will remain questions until further investigations give answers of great importance to both internist and surgeon.

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Fig 3 Part of Figure 2 deeper section. Captured vessel seen at the bottom of the erosion. profuse hemorrhage into the mucosa to the right of the erosion $\times 23$



Fig 4 Same erosion as in Figure 3 deeper section. Hemorrhage more marked. Disintegration of the mucous membrane in this area $\times 23$

and prepared for histological examination. Both specimens came from operations for duodenal ulcers. Incidentally in both cases the duodenal ulcers were inoperable due to their size and due to penetration into the pancreas, therefore a resection *zur Ausschaltung* was performed (17).

The macroscopic examination of the formalin fixed specimens revealed similar pictures in both cases. In one case about 12 and in the other about 8 small defects were found. The greater number of these defects were situated along the lesser curvature while the remainder



Fig 5 Specimen No. 9861 1936. This specimen shows the presence of a chronic ulcerative gastritis. Penetrating ulcer $\times 19$



Fig 6 Specimen No. 9861 1936. Chronic ulcerative gastritis. Muscularis mucosa perforated at the bottom of the ulcer. Fibrous tissue development in neighborhood of ulcer $\times 35$

ADVANCED EXTRA-UTERINE PREGNANCY

M ALEXANDER NOVEY, M D., F A.C S., Baltimore, Maryland

THE lodging and imbedding of a fertilized ovum in any situation outside the lumen of the uterus is spoken of as extra-uterine pregnancy, ectopic pregnancy or eccyesis. The development of this fecundated ovum so abnormally located may continue for a variable period of time, depending upon its situation and many other factors involving the reaction of the tissues of the host.

Space does not permit a detailed discussion of the interesting history of extra-uterine pregnancy, beginning with the first recorded case in the middle of the 11th century by Albucasis, an Arabian physician residing in Spain, and extending to the modern conception of its recognition and treatment. The famous lithopedion of Sens reported in the early part of the 16th century, Cornax's case a little later, and the operation by Christopher Ban about the same time for a long retained fetus, all afford a charming picture of some of the earlier reported cases. From this time on instances of the operative removal of a petrified fetus were sporadically reported, first by Prime-rose in 1594, and later followed by others. Evidently in all of these early cases pregnancy was well advanced, and probably all of the cases fell into the group of secondary abdominal pregnancies.

Mauriceau's description of a case of ruptured ectopic pregnancy in 1669 is delightful and well known. Pierre Dionis in 1718 contributed enormously to the known knowledge on this subject in his works. The literature from this time on began to contain more and more on this interesting phenomenon, a very important treatise being written in 1837 by Dezeimeris, revising the older classifications and carefully studying the pathology involved. Many important contributors to the literature on this subject are of necessity omitted. The very slow recognition of the importance of operative interference in extra-uterine pregnancy is in itself an interesting bit of the history of medicine, extending even up to our own day and time.

Extra-uterine pregnancies may be divided into primary and secondary types. They are called primary when development of the fertilized ovum occurs at a point where it is first imbedded, and secondary when the development occurs at a new

site because of rupture or of extrusion from the original location. If there is no treatment, one of several things may happen. The ovum may die and be resorbed, a tubal mole may be formed, a hemocele may develop or, if fetal development continues for a longer time, lithopedion formation, mummification, adipocere formation, skeletonization, or suppuration may occur.

The following tables taken from Schumann's monograph on extra-uterine pregnancy give clearly the primary and secondary terminations of this condition:

TUBAL PREGNANCY

Primary terminations

1. Early death of the ovum with complete resorption and a restoration of the tube to its pre-pregnant condition.

2. Death of the embryo with the formation of a tubal mole.

3. Tubal abortion.

4. Rupture of the pregnant tube, either into the peritoneal cavity or between the folds of the broad ligament.

5. The growth and development of the embryo may proceed to term when either the fetus dies as a result of nutritional failure or is delivered by abdominal section.

6. If the pregnancy be interstitial, the fetus may gradually be extruded into the uterine cavity, the placenta remaining attached to the cornual wall, and the pregnancy may terminate by spontaneous vaginal delivery, as in normal intra-uterine gestation, the placenta being also spontaneously expelled.

Secondary terminations

Tubal rupture or abortion, but far more commonly the former, may be succeeded by:

1. Tubo-abdominal pregnancy, with the placenta remaining attached to the tube wall, either wholly or in part, and the fetus expelled through a rupture of the tube on its free surface, and lying free in the abdominal cavity, surrounded by the amniotic sac or in rare cases entirely devoid of covering. This type of termination is rare although a fairly large number of cases has been reported.

2. Secondary abdominal pregnancies,—that condition found when, following tubal rupture or abortion, more commonly the latter, the entire

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Tubal rupture or abortion, but far more commonly the former, may be succeeded by:

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- 2 Secondary abdominal pregnancies,—that condition found when, following tubal rupture or abortion, more commonly the latter, the entire

ovum is expelled into the general peritoneal cavity and the embryo continuing to live, the placenta attaches itself to whatever tissue it may and re imbedding takes place in an entirely new location.

3. Tubo-ovarian pregnancy, occurring when the fetal sac is composed partly of tubal and partly of ovarian tissues. Here the pregnancy may originate in a tubo-ovarian cyst or more commonly in a tube the fimbriated extremity of which was previously adherent to the ovary.

4. Intraligamentous pregnancy, resulting when the tube ruptures between the folds of the broad ligament and the placenta remaining attached to its tube the fetus develops within the broad ligament the entire gestation remaining extra peritoneal.

Termination of ovarian pregnancy

1. Rupture into the peritoneal cavity with hemorrhage and death of the fetus.

2. Rupture of the sac with secondary ovario-abdominal pregnancy, the placenta remaining attached to the ovarian parenchyma and to contiguous structures.

3. Rupture with secondary attachment of the ovum or secondary abdominal pregnancy.

A brief resume of several cases which have come to our attention may serve to bring out some of the points of importance in the diagnosis and treatment of well advanced extra uterine pregnancy. The errors committed in some of the cases cited should be of value in a study of this condition.

CASE 1. H. F. colored age 24 years married multipara. This patient was admitted to the University hospital October 20, 1920. Her previous pregnancy occurred 6 years ago and presented no abnormalities. On November 22, 1919, she menstruated normally. Her previous menstrual period was normal. Beginning with December amenorrhea had persisted. December 15, the patient had an acute pain over the left tubo-ovarian region which lasted for several days and gradually subsided. Her pain entirely disappeared after about 2 or 3 weeks. Fetal movements were first noticed in April of the following year. On August 10 the patient had what appeared to be labor pains for 2 days, which gradually subsided and the fetal movements which heretofore had been quite pronounced became vague and indefinite. There was a marked decrease in the size of the abdomen and retrogressive changes were noticed in the breasts. Beginning on October 1 the patient had slight vaginal bleeding, which lasted for 5 days. On October 17 the bleeding recurred and continued until the date of admission to the hospital. Throughout all this time the bleeding was only slight in amount except for one occasion when the patient passed what appeared to be a rather large clot. There had been no abdominal pains since August. On admission the patient complained of a slight frontal headache and occasional nausea.

Abdominal palpation showed an ovoid mass about the size of a thirty-two weeks pregnancy the consistency of the tumor being somewhat more resistant and less elastic than normal. No fetal outlines were palpated. The mass was not fixed and was freely movable from side to side. There was a second mass about the size of a grapefruit in the right lower quadrant which was somewhat flattened anteriorly and contracted and relaxed upon palpation. There was marked tenderness over the entire abdomen particularly in the lower left quadrant. No fetal heart could be heard. On vaginal examination the fetal head could be easily felt bulging in the pelvis pushing down into the cul de sac. Anteriorly a soft patulous partially dilated cervix could be made out very high in the vagina which seemed to be continuous with the smaller contracting tumor occupying the right lower quadrant. The patient bled moderately but continuously from the cervix.

A diagnosis of secondary abdominal pregnancy was made and the peritoneal cavity was opened. A dark grayish dull sac was exposed which was adherent to the abdominal peritoneum. Many adhesions to the large and small intestine were encountered some of which required ligation. The tumor extended deep into the pouch of Douglas and at its lowest point could not be entirely separated. The tube and ovary on the right side were intact although they were adherent to the sac wall. On the left side the tube was evident at the uterine insertion only for about 5 centimeters and from that point was lost in the sac wall. The left ovary was not seen probably being concealed by adhesions. Incision into the sac wall immediately exposed placental tissue. A considerable quantity of meconium stained amniotic fluid escaped. The child was lying in the left occiput anterior position with the head below the pelvic brim. The sac wall was covered with peritoneum throughout. A full term well developed dead female child much macerated was delivered. After many more adhesions were separated and tied off and the left broad ligament was tied off the entire sac wall consisting of amnion chorion placenta and adhesions was removed—a procedure which resulted in considerable hemorrhage that was finally controlled. Three cigarette drains were inserted back of the uterus and the abdomen was closed with silk-worm gut sutures. The uterus itself corresponded to the size of about a 16 weeks pregnancy. The patient was considerably shocked by the operation and remained so for about 2 hours. She soon rallied and from this time on made a totally uneventful recovery—her temperature never going above 100 degrees. On November 8 she was discharged from the hospital her incision having healed *per primam*. On vaginal examination the uterus was found in normal position freely movable and not sensitive. Her general condition on discharge was excellent.

CASE 2. P. J. colored age 35 years married multipara. About 1910 this patient had a 7 months premature labor cause unknown. On February 14, 1921, she was admitted to the University hospital with a diagnosis of intra uterine death of baby and postmaturity. An attempt was made to induce labor by rupturing the membranes on the following day but since no membranes could be felt it was thought that they had ruptured spontaneously. Castor oil and quinine were given without effect. On February 16 a Vothees bag was introduced and after about 3 hours came away. The patient did not go into labor. On February 21 she was again prepared and anesthetized. The cervix was dilated manually and at this time it was found that the uterus was small being about the size of an orange and empty. Diagnosis now was made of a secondary abdominal pregnancy and plans were made for laparotomy upon her recovery from the previous manipulations.

On February 22 x-ray examination had revealed the presence of a pregnancy, near term, occiput presenting, the position of the fetus unusual with the occiput on a plane about 2 inches below the umbilicus. The extremities extended further laterally than is usually seen. All of these conditions would fit in with an abdominal pregnancy, although from the x-ray examination, it was impossible to tell whether or not the fetus was in the uterus.

Before the laparotomy was performed, however, the patient developed a lobar pneumonia, at the height of which she suffered an acute shock early on the morning of February 26. This was accompanied by very marked abdominal distention which did not improve under treatment. After medical consultation, it was thought best to open the abdomen with a very small button-hole incision. This was done late that night. There escaped considerable gas under pressure, and several quarts of bloody fluid. The patient died before morning.

Autopsy revealed a secondary abdominal pregnancy with sac loose in the abdominal cavity. There was an opening in the lower left corner of the sac, and it was through this that the fluid had escaped into the abdominal cavity.

CASE 3. H. T., colored, age 25 years, married, multipara. This patient was admitted May 18, 1930 at 7:00 p.m. According to her menstrual history, she was about 40 to 42 weeks' pregnant. She had labor pains from April 19 to April 24, which gradually ceased. They did not begin again until May 13, at which time she vomited some blood. These pains lasted for 2 days, ceased, and began again on the afternoon of May 17. No fetal movements had been felt since May 13. During the week prior to admission she had been seen by two colored doctors and one midwife, and at least four vaginal examinations had been made under non-sterile technique.

On admission, her temperature was 101.2 degrees, pulse 140, blood pressure 110/60. The abdomen was markedly distended, rather firm, and somewhat tender on palpation. Laparotomy was done the following day and an extra-uterine pregnancy found. The placenta was attached to the peritoneal surface of the fundus of the uterus and the membranes formed a large sac adherent to the intestines and abdominal wall. A large macerated child weighing 8 pounds, 6 ounces, was contained in the sac, which was extensively infected with colon bacilli.

The patient died on the operating table from shock, infection, and hemorrhage.

CASE 4. A. B., colored, age 31 years, married, primipara. This patient was admitted at 7:00 p.m. on July 5 for prolonged labor, her pains having started at 1:00 a.m. of the same day. Examination under anesthetic revealed the head low in pelvis covered with a thick portion of lower uterine segment. The cervical canal was displaced upward and to the left, and the external os would not admit the tip of the finger. The head, which could not be palpated through the cervix, was pushed up and out of the pelvis and the cervix was drawn down into position with the aid of vulsellum forceps.

On July 8 the patient had not delivered, although the uterus continued to undergo regular contractions. The possibility of abdominal pregnancy was considered and exploratory laparotomy was decided upon. The abdomen was opened, and a mass containing the baby presented directly under the incision. The mass was very thick walled, vascular, and covered with numerous adhesions. It was opened and a living female child weighing 5 pounds 8 ounces was extracted.

The cyst was found to be composed of the right broad ligament and within it were the placenta and the fetal membranes. It was adherent to the right tube and affixed

to numerous coils of the small intestines. The uterus was slightly enlarged and adherent to the left portion of the cyst.

An attempt was made to free the adhesions and deliver the cyst, but this was found to be impossible. The bleeding vessels were ligated and the cavity of the cyst was packed with gauze. The umbilical cord was ligated and cut just long enough to reach out over the abdomen.

The patient's condition at this time was extremely poor. The abdomen was closed in the usual manner, but before the skin closure could be completed, the patient ceased to breathe.

The child, which had a marked congenital deformity of both feet, contracted impetigo during its stay in the hospital, but when this had cleared up it was transferred to the Kerman Hospital for Crippled Children for treatment of the deformity. Its course from this time on was uneventful.

CASE 5. E. J., colored, age 25 years, married, multipara. This patient had delivered normally of a full term, living child 6 years previously. Her family history, past history, and menstrual history were essentially normal throughout. She was admitted to the University hospital August 21, 1932, having been sent in by her family physician with a history of having been in labor for 36 hours. Upon careful questioning, she gave a history of sharp pain in the lower part of her abdomen followed by an illness lasting several days in the early part of her pregnancy. Following this she was up and about and her pregnancy followed an essentially normal course until about 2 weeks before admission. Beginning with this time she had a considerable amount of abdominal discomfort and fetal movements were quite painful.

Examination upon admission to the hospital revealed that the patient had a normal temperature, pulse, and respiration, and a blood pressure of 130/60. Upon abdominal examination, the fetus was found to be extremely palpable and there was some tenderness of the abdomen. The fetal heart was heard beating at a normal rate. Rectal examination revealed the head to be low down in the pelvis but it was impossible to feel the cervix. On vaginal examination it was found that the head was pushing down into the pelvis through the posterior cul-de-sac, and that the cervix was drawn high up behind the symphysis, the cervical canal being only large enough to admit a thin applicator. The abdominal examination, combined with the pelvic examination and the history, served to make a diagnosis of secondary abdominal pregnancy the most likely probability, and the abdominal operation was decided upon. The abdomen was opened the same afternoon under ether anesthesia and the first thing seen was the baby's hand which protruded through the peritoneal incision. The child was lying loose in the abdominal cavity, and was removed without difficulty. It was now possible to see the sac in which the child had been lying, it was apparently made up of broad ligament and was extremely vascular, being in effect a large varicocele sac, the walls of which were thin and friable. There had occurred at some time previous a rupture in the right lower border, and through this rupture the child had escaped into the abdominal cavity.

The placenta, which was apparently attached to the left side of the sac and probably covered a rather large area, was at this time seen to be partially protruding through the rupture, the fetal surface being seen. The cord could be traced down to its placental attachment.

In the manipulation of the sac it began to bleed at what would be the fundus of the uterus, had it been a uterus near the left side. This bleeding began without any instrumentation whatever, and was rather profuse. A clamp was placed on the bleeding area and hemorrhage was controlled in this way, but after two attempts to whip over

the bleeding point with a needle and after an attempt was made to tie it off with a free hand tie it was concluded that the tissues were too friable for successful suturing. Each suture caused a little more bleeding than the last, and finally it was decided to allow the clamp to remain in position.

The sac at this time was about the size of a recently delivered uterus. There was no hemorrhage where it had ruptured and there was no blood in the abdominal cavity. The patient's condition was extremely good and it was feared that if any attempt was made to remove the sac profuse and possibly uncontrollable hemorrhage would be encountered. Therefore the cord was tied close to its placental insertion and severed allowing the ligature to remain outside of the abdomen. Two cigarette drains were introduced near the site of the rupture and the abdomen was closed.

The patient left the table very little shocked and was returned to her bed in good condition.

Following operation the patient ran a surprisingly smooth course. For the first 10 days there was a slightly septic type of temperature never going above 100 degrees and for the next week or so the temperature was essentially normal. Following this it again began to assume a somewhat septic type never completely returning to normal. On October 16, 1932, she was discharged in apparently good condition after having remained in the hospital for about 8 weeks.

It is interesting to note that the sac containing the placenta which was not removed at the time of operation gradually decreased in size so that at the time of discharge one was still able to palpate through the abdominal wall a mass about the size of a small grapefruit which was not tender and easily movable. The patient was instructed to return to the clinic for postpartum follow up.

The baby which weighed 5 pounds 15 ounces at birth lived very nicely and upon discharge weighed 7 pounds 9½ ounces.

The patient was examined at periodic intervals after her discharge from the hospital and after about 18 months pelvic examination was negative except for a very small firm mass in the broad ligament which was freely movable, not tender, and about the size of a walnut. Recently about 3 years after operation the patient delivered spontaneously of a normal full term child after a very short labor.

CASE 6. C. C. colored age 21 years married multipara. This patient was admitted to the Provident hospital October 25 complaining of abdominal pain since October 17. Her first pregnancy was normal the child is living and well at present. The last menstrual period was June 15. On July 25 she fainted twice but had never remained in bed.

On examination a mass was found occupying the left portion of the abdomen. The tumor seemed to be divided into two parts and over the upper portion the fetal heart could be heard. Pelvic examination was extremely painful and quite unsatisfactory. Upon the basis of a possible diagnosis of abdominal pregnancy a laparotomy was done on November 22. Among other factors the anemia and general poor condition of the patient coupled with the great amount of abdominal pain played a great part in the decision to operate without delay.

When the abdomen was opened there was found a sac occupying the left upper abdominal region which contained a fetus. A living child weighing 3 pounds 4 ounces was removed but the infant died of prematurity a few hours later. The sac was closed and the abdominal wall was repaired without the use of drainage. The placenta was left in situ.

The patient had a very stormy convalescence but finally left the hospital on April 15 a small draining sinus still present in the abdominal wound. There was a definite mass in the left lower abdominal quadrant. The general condition of the patient was only fair on discharge.

Follow up examination of the patient 3 months later revealed a gain in weight of about 40 pounds associated with complete healing of the incision and a state of comfort and well being.

In summary, there are reported 6 cases of extra uterine pregnancy with a maternal mortality of 3 and an infant mortality of 4. In addition to these cases, there have occurred several others all of which seemed to demonstrate the seriousness of advanced extra uterine pregnancy, and the ease with which errors in recognition and treatment may be made.

DIAGNOSIS

The diagnosis of abdominal pregnancy in the later months whether primary or secondary, is usually a question of determining if the fetus is really extra uterine. As a rule there is little necessity for the confirmation of the existence of a pregnancy, and the confusing differential diagnosis and symptomatology of the early ectopic gestation does not confront the attendant.

If the pregnancy is well advanced there are certain points of aid in diagnosing an abdominal gestation. The history of an acute attack of illness at a time corresponding to the third or fourth month of pregnancy is of great value. This corresponds to the rupture of an ectopic pregnancy, and the patient states that at this time she suffered an acute sharp pain in one or the other lower abdominal quadrants following which she was quite faint and ill for a week or more. There may or may not have been a slight amount of bloody vaginal discharge at this time. The abdominal discomfort and general malaise may wear off in due time and the patient feel well again, often with little or no medical attention. Frequently however there is a continued semi invalidism and symptoms of peritoneal irritation, such as abdominal pain, nausea and vomiting, alternating constipation and diarrhea, and painful urination. Painful, vigorous and easily demonstrable fetal movements are frequently encountered. On palpation of the abdomen one is impressed by the unusual palpability of the fetus, it being possible at times almost to pick up the small parts through the abdominal wall. If the child is alive the fetal heart tones may be heard very loudly. The abdominal tumor is itself often asymmetrical and the position of the fetus often oblique as regards the midplane of the pelvis. In some instances the enlarged empty uterus

which is drawn up out of the pelvis, by the growing fetal mass, may be felt just above the symphysis to the right or left or in the midline. The sac containing the fetus does not contract, and often in a case of suspected abdominal pregnancy, a firm, strong contraction of the abdominal mass makes a positive diagnosis of an intra-uterine gestation. In general, the abdominal examination is painful and unsatisfactory.

If the fetus has gone to term, there usually occurs what is known as false labor, often associated with some vaginal bleeding. This continues for a short time, when fetal death occurs, and movements and uterine contractions cease.

On rectal examination, one may be misled by the degree to which the head of the fetus has descended into the birth canal, at times even to the level of the ischial spines. On careful palpation one is, however, unable to make out the cervix, the low level of the head occurring as the presenting part descends covered by one of the cul-de-sacs. The writer knows of several attempts to rupture the membranes in such cases because a diagnosis of abdominal pregnancy had not been made.

Vaginal examination reveals the soft cervix of pregnancy but in our experience in almost every instance the cervix is so pulled upward by the displaced uterus that it is found with great difficulty, and then only as a tiny opening well up under the symphysis, the lips of the cervix often not being palpable at all. There is present no evidence of Hegar's sign. The body of the uterus is often palpable, varying in size from a comparatively small organ to that of a 20 weeks' pregnancy. Its consistency varies but as a rule it is much less firm than the uterus in the non-pregnant condition. It is most often displaced by, and usually can be outlined as, a separate and distinct structure from the sac containing the fetus.

The x-ray as an aid in the diagnosis may be of value, in determining the oblique and atypical position of the fetus as regards the midplane of the pelvis. The use of the uterine sound or skiagraphy may be of value in establishing a diagnosis if properly employed.

TREATMENT

In any consideration of the treatment of advanced extra-uterine pregnancy, it is essential to consider not only the life of the mother but also the possible infant life, if the fetus is still alive. Here, as in many other situations throughout the practice of medicine, no set rule can be established for treatment, but each case must be in-

dividualized and treated as that particular case demands.

Immediate operation as contrasted to waiting until the fetus reaches the period of viability is recommended by some very good authorities. On the other hand, there are many who favor close observation of the patient to be followed by laparotomy at a time when the child is thought to be viable. It is true that in a certain number of instances malformations of the fetus are encountered, but the presence of normal, healthy children is sufficiently frequent to discount this point as a reason for immediate interference. If the patient is at term, some recommend waiting for false labor to occur and the subsequent death of the fetus, and then about one to three weeks later to operate, hoping that the decrease in blood supply at this time will render the operation more safe. This has not been found advisable by many, and, in the writer's opinion, far better results can be obtained by operating 1 or 2 weeks before term, a procedure, in the hands of many, fairly frequently resulting in a living mother and baby. In the event that the fetus is known to be dead, the delay of several weeks may be advisable until thrombosis of the placental vessels has occurred, rendering operation less formidable.

If possible, the sac should be incised extra-peritoneally, but this is not always feasible. The fetus should be removed and the placenta should be treated in different manner, depending on its site of attachment. Where the placenta is attached to the omentum, intestines, peritoneal wall, and the surface of the uterus, any attempt to separate it is extremely dangerous. It should be left alone, drains should be inserted, and the placenta should be allowed to slough out. If, on the other hand, the placenta lies between the folds of the broad ligament and there is no infection present, the placenta should be left *in situ*, the sac tightly closed, and the abdominal cavity closed without drainage. Attempts at removal of the placenta in most instances is attended by uncontrollable hemorrhage. In rare instances, the entire blood supply of the sac can be ligated, and the sac and placenta within removed; but unless this is extremely easy to do it is best not to attempt it. In a definitely infected case, marsupialization, stitching the edge of the sac to the abdominal wound, and packing the sac with gauze, often gives the best results. Each case, therefore, must be handled as it demands and it is highly important to decide the procedure to be followed as early as possible and to avoid unnecessary manipulation with exposure of the patient to serious hemorrhage and infection.

the bleeding point with a needle and after an attempt was made to tie it off with a free hand tie it was concluded that the tissues were too feeble for successful suturing. Each suture caused a little more bleeding than the last and finally it was decided to allow the clamp to remain in position.

The sac at this time was about the size of a recently delivered uterus. There was no hemorrhage where it had ruptured and there was no blood in the abdominal cavity. The patient's condition was extremely good and it was feared that if any attempt was made to remove the sac profuse and possibly uncontrollable hemorrhage would be encountered. Therefore the cord was tied close to its placental insertion and severed allowing the ligature to remain outside of the abdomen. Two cigarette drains were introduced near the site of the rupture and the abdomen was closed.

The patient left the table very little shocked and was returned to her bed in good condition.

Following operation the patient ran a surprisingly smooth course. For the first 10 days there was a slightly septic type of temperature never going above 100 degrees and for the next week or so the temperature was essentially normal. Following this it again began to assume a somewhat septic type never completely returning to normal. On October 16, 1932, she was discharged in apparently good condition after having remained in the hospital for about 8 weeks.

It is interesting to note that the sac containing the placenta which was not removed at the time of operation gradually decreased in size so that at the time of discharge one was still able to palpate through the abdominal wall a mass about the size of a small grapefruit which was not tender and easily movable. The patient was instructed to return to the clinic for postpartum follow up.

The baby which weighed 5 pounds 15 ounces at birth did very nicely and upon discharge weighed 7 pounds 9 1/2 ounces.

The patient was examined at periodic intervals after her discharge from the hospital and after about 18 months pelvic examination was negative except for a very small firm mass in the broad ligament which was freely movable not tender and about the size of a walnut. Recently about 5 years after operation the patient delivered spontaneously of a normal full term child after a very short labor.

CASE 6. C. C. colored age 21 years married multipara. This patient was admitted to the Provident Hospital October 25 complaining of abdominal pain since October 17. Her first pregnancy was normal the child is living and well at present. The last menstrual period was June 15. On July 25 she fainted twice but had never remained in bed.

On examination a mass was found occupying the left portion of the abdomen. The tumor seemed to be divided into two parts and over the upper portion the fetal heart could be heard. Pelvic examination was extremely painful and quite unsatisfactory. Upon the basis of a possible diagnosis of abdominal pregnancy a laparotomy was done on November 22. Among other factors the anemia and generally poor condition of the patient coupled with the great amount of abdominal pain played a great part in the decision to operate without delay.

When the abdomen was opened there was found a sac occupying the left upper abdominal region which contained a fetus. A living child weighing 3 pounds 4 ounces was removed but the infant died of prematurity a few hours later. The sac was closed and the abdominal wall was repaired without the use of drainage. The placenta was left in situ.

The patient had a very stormy convalescence but finally left the hospital on April 25 a small draining sinus still present in the abdominal wound. There was a definite mass in the left lower abdominal quadrant. The general condition of the patient was only fair on discharge.

Follow up examination of the patient 3 months later revealed a gain in weight of about 40 pounds associated with complete healing of the incision and a state of comfort and well being.

In summary, there are reported 6 cases of extra uterine pregnancy with a maternal mortality of 3 and an infant mortality of 4. In addition to these cases there have occurred several others all of which seemed to demonstrate the seriousness of advanced extra uterine pregnancy, and the ease with which errors in recognition and treatment may be made.

DIAGNOSIS

The diagnosis of abdominal pregnancy in the later months whether primary or secondary is usually a question of determining if the fetus is really extra uterine. As a rule there is little necessity for the confirmation of the existence of a pregnancy and the confusing differential diagnosis and symptomatology of the early ectopic gestation does not confront the attendant.

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ANAEROBIC INFECTIONS FOLLOWING OPERATIONS ON THE URINARY TRACT

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THE occurrence of an anaerobic infection complicating surgical procedures on the urinary tract seems to be infrequent, as evidenced by the paucity of case reports. Yet, the development of this type of infection is of such serious moment as to warrant calling attention to the importance of early recognition and treatment. The reader is referred to an article by Goldstein and Abeshouse in which the literature on *Bacillus welchii* infections is reviewed *in extenso*. Since then, Turner added 2 other cases of *Bacillus welchii* infection: one followed a nephrotomy for stone and ended fatally, while the second followed a nephrectomy for renal calculus with cortical abscesses, and ended with recovery. In addition to these, we have been able to find references to 3 cases of tetanus. Two of these cases were reported by Wainwright and followed prostatectomy, the third, reported by Miller and Rogers, occurred after a nephrectomy.

Of the 27 cases of gas bacillus infection after operations on the urinary tract which were found in the literature, the outcome was mentioned in 22. The calculated mortality for this series is 45 per cent. All 3 instances of tetanus ended fatally.

Following are the abstracts of 14 cases of post-operative anaerobic infection of the urinary tract that were encountered at Mount Sinai Hospital during the past 11 years. Eleven were due to *Bacillus welchii*, and 3 showed the typical symptoms of tetanus.

INFECTION DUE TO GAS BACILLUS

CASE 1. A R., aged 61 years, had had three series of x-ray treatments for an enlarged prostate. May 21, 1931, a suprapubic cystostomy and lithotomy were done. One week later, two large, adherent prostatic adenomas were enucleated and the prostatic bed was packed with thromboplastin soaked gauze. The same afternoon, the patient bled from the prostatic bed and had to be repacked. This was followed by the administration of a transfusion of 500 cubic centimeters of blood. At midnight of the same day, another hemorrhage necessitated a second repacking and transfusion. Thirty-six hours following this, the patient's high temperature forced the removal of one packing. Several hours later, a serous and urinous discharge containing gas bubbles was noted alongside the remaining packing. Smears from this fluid showed the presence of gram

positive thick rods and on culture the organism was found to be *Bacillus welchii*. In view of this finding and the temperature of 104 degrees, the remaining packing was removed; the wound was opened widely; polyvalent anaerobic serum was administered intramuscularly and continuous irrigation with hydrogen peroxide was instituted. The patient's condition improved and 1 week later the suprapubic tube was removed. This was followed by a third hemorrhage, which was controlled by packing the prostatic bed. A week later the packing was removed, and a fourth, and fatal hemorrhage followed.

In this case the anaerobic infection was controlled, as evidenced by the subsequent negative cultures and smears. Death occurred 2 weeks after the infection was first noted, and was due to hemorrhage. Possibly the frequent packing of the prostatic bed may have been accompanied by contamination with *Bacillus welchii*.

CASE 2. L. B., aged 60 years, male, had a nephrectomy for left renal carcinoma September 1, 1931. The following day, crepitation was noted about the wound. The latter was opened widely after smears suggested the presence of a gas bacillus infection. Culture subsequently verified the presence of this organism. The patient was given polyvalent serum and the wound was irrigated through catheters in the depths with hydrogen peroxide. Recovery was uneventful, though the wound healed slowly, and he was discharged October 25, 1931.

This is the only case of anaerobic infection following nephrectomy in over 150 cases of renal neoplasm. As far as we know, the operative technique was identical in all these cases. The tumor was infected and broken down. Whether the organism was already present in the tumor (which ruptured during delivery), or was introduced in other ways, cannot be stated.

CASE 3. A. E. R., aged 60 years, male, was operated upon February 25, 1932; a right pyelotomy and nephrotomy were done under x-ray control for renal calculi, as described by Beer and Benjamin. Three days after operation his temperature was 102 degrees, but he showed no signs of toxicity. When the wound was dressed the surrounding area was found to have a purplish discoloration with distinct crepitation. The superficial and deep sutures were then removed, revealing the presence of necrotic tissues, pus, and air bubbles. Smears and cultures were positive for *Bacillus welchii*. Serum was administered and irrigations of the wound with hydrogen peroxide were instituted. His temperature subsided and the wound gradually cleared and granulated. He was discharged 6 weeks after operation.

In addition to all the factors which may have been responsible in the previous case, there were

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SUMMARY AND CONCLUSIONS

From the preceding discussion, it can be seen that we are dealing here with a formidable condition, which necessitates a great amount of diagnostic skill, seasoned judgment, and proper handling if one is to avoid a tremendous mortality rate. In general, it is safe to say that indecision and faulty treatment of the placenta and fetal sac will add more than anything else to a tragic result. In spite of the fact that each case must be handled individually, certain points will be found of value in the diagnosis and treatment of a well advanced extra uterine pregnancy.

As to diagnosis, the following points are important:

- 1 History of rupture in the early months with its accompanying signs and symptoms
- 2 Painful fetal movements
- 3 Extremely easily palpable fetus
- 4 Tender abdomen on palpation.
- 5 Palpation and demonstration of a small

empty uterus separate and distinct from the sac containing the fetus

6 Markedly retracted cervix, high up under the symphysis

7 Failure of the fetal sac to contract

8 Asymmetry of the mass on palpation and by x ray

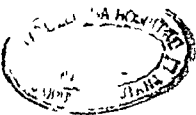
As to treatment, the following should be mentioned:

1 The patient may be safely carried under close observation to a period when the fetus is viable

2 Attempt should be made to open the sac extraperitoneally

3 Each case should be studied individually but wherever possible the placenta should be left *in situ* and the sac and the abdominal cavity closed without drainage

4 Unnecessary manipulation should be avoided for it will almost invariably result in death of the patient from shock, hemorrhage or infection



lus welchii in one flask. Smears and cultures were taken from the sinus tract and were found to contain gas bacilli. Serum and peroxide irrigations were administered. By the third day following this therapy, the temperature had fallen from 103.6 to 100 degrees. The cultures from the wound showed *Bacillus welchii* for 4 weeks. Her convalescence thereafter was uneventful.

This case is of interest because (1) there were no local manifestations of anaerobic infection; (2) the complication was first suggested by the positive blood culture; (3) the possibility arose that a localized *Bacillus welchii* phlebitis of the inferior vena cava existed at the point of application of the clamps. This patient, as well as 2 patients mentioned by R. K. Ghormley are the exception to the statement of Rhodes that "when gas bacillus infection invades the blood stream, the outcome is fatal."

CASE 7. A. L., aged 50 years, male, was admitted to Mount Sinai Hospital April 11, 1936, for a left upper abdominal mass, which was ballotable from the lumbar region and felt cystic. In addition, he had a considerably enlarged prostate gland. Ten days later, April 21, 1936, exploration under spinal anesthesia revealed a cyst the size of a grapefruit in the lower pole of the left kidney and a smaller one in the upper pole. Both cysts were evacuated and the cyst walls were removed. At the same sitting, a suprapubic cystostomy was done. The postoperative course was uneventful, except for a daily rise in temperature to 101.8 degrees. On the seventh day, some pus was evacuated from the posterior portion of the lumbar wound, which on smear and culture showed the presence of *Bacillus welchii*. Blood culture was negative. Polyvalent serum and peroxide irrigations were given, as well as oxygen introduced through a tube in the depths of the wound, which was opened widely. Except for a slowly granulating wound, the subsequent course and recovery were uneventful, and 2 months later a second stage prostatectomy was performed.

CASE 8. L. B., aged 50 years, male. Operation, September 3, 1930, consisted of right nephrectomy for tuberculosis. On the second day after operation, patient developed an acute dilatation of the stomach which contained over 50 ounces of retained fluid. On the third day, the temperature was 104 degrees, there was marked abdominal distention and the patient hiccoughed occasionally. Flatness and diminished breathing at the right base were noted. The wound was inspected and definite crepitation was found in the anterior two thirds of the line of incision. Immediate smears were made and were found to be positive for gram positive bacilli. Cultures were reported positive for *Bacillus welchii*. The wound was laid open widely, and irrigated with oxygen and Dakin solution. Polyvalent anaerobic serum was administered intramuscularly. The patient's general condition at this time was only fair. X-ray examination of the chest revealed marked elevation of the right leaf of the diaphragm. In view of the possibility of a subphrenic abscess, the wound was explored in the upper angle. The exploring finger found a cavity going up toward the diaphragm and turning inward. There was a discharge of about an ounce of old blood, following this procedure, and in addition a slight puff of air was noted. The patient was cyanotic during this time and required oxygen administered in a tent. Despite vigorous measures to support the patient and at the same time to combat the anaerobic infection, patient died on eighth day after operation.

It is possible that the anaerobic infection was overlooked or did not become manifest until the third day after operation. Earlier diagnosis might have made a difference in this case.

CASE 9. E. A. R., aged 24 years, male, was operated upon December 17, 1936, at which time a pelvic ureterolithotomy was performed. The incision in the ureter was closed with three interrupted adventitial sutures. The night after operation the temperature rose to 103 degrees. Inspection of the wound was negative. The patient ran some temperature for 6 days. During this period a small amount of pus was evacuated from the superficial part of the wound. On the sixth day after operation, the temperature rose sharply to 105 degrees. There was slight urinary leakage from the wound. Definite gas bubbles could be expressed from the depths of the wound. Immediate smear was made of the pus and reported positive for gram positive bacilli. Later cultures grew *Bacillus welchii*. The wound was laid widely open under anesthesia. Several Dakin tubes and catheters were inserted for continuous irrigation with hydrogen peroxide, and Dakin solution alternately. In addition, Lederle polyvalent anti-gas serum was administered intramuscularly and also placed in the wound. Following this regimen, the wound became clean quickly, and the patient was discharged with the wounds well healed 1 month after operation.

CASE 10. G. W. K., aged 50 years, male. Patient had the first stage of a proposed two stage suprapubic prostatectomy. Following the first operation, he developed a rise in temperature, which was at first thought to be due to an acute exacerbation of a chronic pulmonary process. Examination of the wound revealed crepitus in the upper angle, and a suture was removed. A small amount of thin pus and gas was expressed. Smears and culture were positive for anaerobic bacilli of the *Bacillus welchii* type. The patient's temperature was not particularly high, and his general condition was good. Adequate drainage of the superficially infected wound was obtained. Infection cleared up quickly without resort to drastic wound cleansing measures. Subsequent smears and cultures were negative. Patient was later subjected to second stage of operation.

This case is an example of mild anaerobic infection, which cleared up after simple drainage measures.

CASE 11. F. M., aged 44 years, female, was a case of calculus in the pelvic portion of the right ureter. A tooth in a dermoid ovarian cyst on this side was at first mistaken for the calculus. At operation, the stone was found in the ureter just below the shadow cast by the tooth. On re-examination of the x-ray plates, the smaller calculus shadow was identified. After removal of the calculus the ureter was sutured with plain catgut, and rubber dam was employed for drainage. Immediately after operation, the temperature rose to the 102-103 degrees level and remained there. Copious urinary leakage occurred through the wound, but despite the copious drainage the temperature remained elevated. One week after operation, massive edema of the posterior-vaginal wall was noted. A diagnosis of retroperitoneal cellulitis due to urinary extravasation was made. Blood culture was positive for the *Streptococcus hemolyticus*. A catheter was passed up into the right renal pelvis and left indwelling. The patient's condition became steadily worse and she ceased. At the postmortem examination, a gas bacillus infection of the wound was found and *Bacillus welchii* cultured from the liver and lungs. In addition, there were found an acute peritonitis,

three additional possible sources of contamination (1) urine (2) calculi, (3) x ray control

The next case is presented in greater detail because of the various unusual features attributable directly and indirectly to the gas infection

CASE 4 H S H aged 36 years male was admitted to the hospital June 3 1933 with a diagnosis of right renal tuberculosis and left tuberculous epididymitis. For 5 years he had had pains in both lumbar regions and in the penis. There was a definite history of the passage of gravel. X ray examination revealed calcifications in the right kidney and in the regions of the upper and lower ureter on the right side. Physical examination revealed a typical tuberculous left epididymis and some bilateral lumbar tenderness. There were a few nodules at the base of the right lobe of the prostate atrophy of the left lobe and a thickened left seminal vesicle. Cystoscopy was carried out the bladder urine was found to be cloudy the left ureteral orifice was normal and when catheterized yielded a clear urine without pus strong indigocarmine was present and no tubercle bacilli were found. The right ureter was obstructed temporarily at 4 centimeters and 11 centimeters but the catheter was finally passed to the right renal pelvis. From this side there was no excretion of indigocarmine and the urine showed many pus cells with tubercle bacilli in the centrifuged smears.

June 10 1933 an aseptic nephro ureterectomy (Ree technique) was performed and in addition through a separate inguinal incision a left orchidectomy was done. Due to the marked perinephritis the kidney was removed subcapsularly. The specimen showed a small right kidney adherent in the thickened perinephric fat. The ureter was dilated thickened and markedly adherent in the region of the ureterovesical junction where several small impacted calculi were noted. In lower pole of kidney was a partially calcified abscess while the other calices showed calculosis.

The day following operation the patient's temperature rose to 105 degrees and was attributed to a sore throat. The temperature and throat infection began to subside but on the fifth day after operation about 3 ounces of sero pus was evacuated from the anterior angle of the lumbar wound. The following day when three chromic sutures were removed there was an escape of pus fat globules and air bubbles from the depths of the wound. Cultures and smears were positive for *Bacillus welchii*. Polyvalent serum was administered and through two catheters in the bottom of the wound the latter was irrigated with hydrogen peroxide. By the eighth day the lumbar wound seemed cleaner but crepitation and tenderness were noted in the anterior ureterectomy wound. The temperature rose to 105.4 degrees. The ureterectomy wound was therefore split open and a tube was introduced into the pelvis for oxygen and peroxide insufflations. Cultures from this wound also showed *Bacillus welchii* but the blood culture was negative. This was followed by a subsidence of the fever to almost normal. Serum was still administered. On the twelfth day the temperature again rose to 104 degrees. The right lumbar and anterior wounds were clean but there was tenderness in the left iliac fossa. Rectal examination was negative.

Fifteenth day after operation temperature was 102-104 degrees respirations rapid rectal examination negative blood pressure 70/50 hemoglobin 76 per cent white blood count 35,000 with 82 per cent polymorphonuclears.

Twenty first day signs of consolidation over left lower lobe. Given a transfusion of 300 cubic centimeters of blood.

Thirtieth day temperature still 102-104 degrees rises present at both bases.

Thirty second day irrigation of the anterior wound yielded a considerable amount of pus and necrotic tissue temperature lower.

Forty second day an indurated tender mass appeared over the left pubic bone. Flat x ray showed the catheter to enter the right side of the pelvis and to extend to the left pubic region. It was felt that this abscess accounted for the fever diarrhea and persistent discharge. The following day incision with drainage of the left inguinal abscess was performed.

Forty seventh day patient voided for the first time a milky urine with some blood. The fourth voiding was again clear. It was thought therefore that this was due to a rupture of an extraperitoneal abscess into the bladder. A few days after this he began to improve and he was discharged from the hospital 70 days after operation.

During the patient's stay in the hospital opaque material injected into the right sinus tract appeared to run behind the rectum and sigmoid in the hollow of the sacrum. The wounds continued to drain for some time after discharge from the hospital. He was readmitted March 27 1933 and a retrorectal abscess of the pelvis was drained after the coccyx was removed. Following this procedure all wounds rapidly closed.

In this case at one time the diagnosis of miliary tuberculosis was entertained. The extensive dissection of the retroperitoneal infection from the right to the left side behind the rectum may have been due to the anaerobic organism or to the measures used to combat the gas bacillus. It is questionable whether this patient would have recovered without careful watching and early recognition of complications.

CASE 5 J L aged 22 years male had a right nephrectomy for tuberculosis in May 1933. On the second day after operation his temperature rose to 104 so that it was deemed advisable to inspect his wound. Definite crepitation was found and when the sutures were removed smears from the depths showed large gram positive rods, which on culture were subsequently found to be *Bacillus welchii*. The wound was immediately opened widely and continuous irrigations with hydrogen peroxide were instituted. Polyvalent serum was also given. Cultures from the wound were positive for gas bacilli for 335 weeks. His subsequent course was uneventful.

CASE 6 R W aged 42 years female was subjected to a right nephrectomy March 6 1934 for a calculous pyonephrosis. The kidney was enlarged and very adherent to all the surrounding tissue. After ligation of the pedicle and removal of the kidney profuse bleeding ensued which was found to come from an opening in the vena cava. Bleeding was controlled by the application of clamps to the opening in the vena cava. Due to the friability of the infiltrated wall of the vessel the opening was not sutured but the clamps were left in place. For one week after operation the patient's condition was satisfactory the temperature ranged between 100 and 101. On the ninth day the clamps were removed and the wound appeared clean except for some serosanguineous discharge along the drainage tract. Despite her apparently good general condition the temperature between the tenth and fourteenth days after operation varied between 100 and 103 degrees. There were no local evidences of wound infection. A blood culture was taken and to our surprise it showed the presence of *Bacil*

POSSIBLE SOURCES OF INFECTION

The occurrence of postoperative anaerobic infections has always given rise to theoretical discussions as to the portals of entry. The following sources of contamination are to be considered: (1) skin, (2) rectum, (3) operative materials, and (4) urine, pus and urinary calculi

1. *Skin* Park and Williams and Gilles comment on the presence of the *Bacillus tetani* in the dirt about the feet, hair, street clothes, and dust in the house and hospital. Meyer and Spector in culturing the skin of the inguinal region found 5 positive cultures of *Bacillus welchii* before and 2 positive cultures after surgical preparation of the skin. These facts are self evident and emphasize the importance of meticulous care in the cleansing and sterilization of the skin before operation, as the first step in the control of postoperative anaerobic infections.

2. *Rectum* It is well known that both *Bacillus tetani* and *Bacillus welchii* may be harbored normally in the lower intestinal tract. This incidence has been variously estimated from 1 to 2 per cent in urban districts to 40 per cent in the rural population (6, 11, 27). The reasons for this difference are self evident. Several cases of postoperative tetanus have been reported in which positive cultures of tetanus bacilli were obtained from the stool of the same patient. In one of Tulloch's cases, following appendectomy, the organism was isolated from the wound, from the stump of the appendix, and from the descending colon. Speed recovered the organism from the exudate around a deep stitch which passed through the sigmoid during a hernioplasty. These reports indicate a possible association between postoperative tetanus and the lower intestinal tract. It is of interest to note that our 3 cases of tetanus followed a second stage prostatectomy. In the usual technique of suprapubic prostatectomy, the enucleation of the adenoma is facilitated by the introduction of a finger into the rectum. Anaerobic organisms from the latter may then find their way into the wound or prostatic bed by migration through the bruised layer of tissue separating the prostate from the rectum or by faulty technique in the care of the contaminated rectal glove or hand.

3. *Operative materials* Numerous substantial reports are to be found in the literature (19) of anaerobic infections due to contaminated catgut. In investigating a few other sources, cultural studies were made of a hemostatic agent used in packing the prostatic bed (7). Much to our surprise, this hemostatic agent was found to be contaminated with various types of organisms. Al-

though tetanus bacilli were not isolated from this preparation, organisms resembling *Bacillus welchii* were found. It is obvious that the use of such contaminated materials may be another means of introducing anaerobic organisms into the wound.

4. *Urine, pus, and urinary calculi.* Weiser reported the case of a 60 year old man with hematuria and pneumaturia. Culture from the urethra and bladder yielded *Bacillus welchii*, staphylococci, and streptococci. Bennett noted the abundant presence of *Bacillus welchii* in the urine of a patient whose kidney had been traumatized by a projectile without the development of an anaerobic infection. Doering cultured anaerobic organisms from a patient with a perinephric abscess secondary to a pyonephrosis. Albarran and Cottet stated that in rare cases, cystitis may be induced by anaerobic bacteria alone or in combination with aerobic organisms. Duvoir et al. mention a case of tetanus with cystitis that followed the introduction of a sound into the bladder in an attempted abortion with recovery from the tetanus and continuation of the pregnancy. Runeberg isolated anaerobic bacteria 6 times from the urines of 47 patients with urinary calculi.

In the past 3 years, over 1,000 cultures from the genito-urinary tract were made at Mount Sinai Hospital. In two instances, *Bacillus welchii* was recovered from the urine. The first patient was a man who was admitted with symptoms of a right pyelonephritis and prostaticitis, 6 weeks after a transurethral resection at another hospital. This man recovered. The second patient was a colored male of 27 years, who was explored for acute upper abdominal symptoms. Laparotomy showed edema of the peritoneum and gastrocolic omentum and an incidental appendectomy was performed. After operation he had a moderate fever and marked oliguria with a rise in his blood urea to 120 milligrams per cent. Gross hematuria appeared on the fourth day, and evidences of a gas bacillus infection developed on the eleventh day after operation, at which time his urine culture was also positive for *Bacillus welchii*, but his blood culture was negative. Postmortem examination revealed a bronchopneumonia, peripancratic and perirenal fat necrosis, a necrotizing cystitis, and hemorrhages into the renal pelvis. This case clearly showed that anaerobic organisms may find their way into the urinary tract from other tissues which may harbor these bacteria. It has been shown by Franck in about 20 per cent of the cases he studied that the lymph channels of the right kidney capsule are intimately related to the appendix and cecum. He believes that this lymphatic arrangement is at times responsible

right traumatic (operative) ureteritis acute phlebitis of the left ovarian vein thrombosis of the right renal vein embolism of the left lower pulmonary artery and dermoid cyst of the right ovary

INFECTION DUE TO TETANUS BACILLUS, ALL AFTER A SECOND STAGE PROSTATECTOMY

CASE 1. L. H. aged 65 years male was admitted to the hospital and a suprapubic cystostomy was done January 16 1931 under local anesthesia. Convalescence was uneventful so that on January 23 1931 the second stage prostatectomy was done under gas-oxygen anesthesia. Two very large lateral lobes and a median lobe were enucleated and the prostatic bed packed with three thromboplastin soaked packings. These packings were removed as usual on the fifth day after operation and the patient was allowed out of bed the following day. Eleven days after the second stage (February 4) the patient began to complain of difficulty in opening his mouth widely. Physical examination at this time was entirely negative. There was no apparent spasm of the masseters and the mouth could be opened the full distance. That evening he developed typical trismus which became more intense and was accompanied by rigidity of the abdominal muscles and exaggeration of all the deep reflexes. The clinical picture resembled typical tetanus. He was given tetanus antitoxin intramuscularly and large doses of sedatives. His temperature was only 100 degrees at this time. The following day although he felt better subjectively there was still some difficulty in swallowing. The temperature then rose to 104 degrees and the general condition became progressively worse. February 8 he developed signs of pneumonia at the right base and he died February 10 1931. Postmortem examination was not obtained.

CASE 2. G. K. aged 68 years male had a suprapubic cystostomy under local anesthesia November 19 1931 for enlargement of his prostate. Except for the development of a left scrotal abscess which was incised and drained his postoperative course was uneventful. Accordingly December 8 1931 the second stage prostatectomy was performed parascrotal and epidural block anesthesia being used. After the large prostate was removed in several pieces the bed was packed with two packings soaked in thromboplastin gauze and the bladder was drained with a large tube. Immediate postoperative course appeared normal and the packings were removed on the fourth day. Ten days after the second stage the patient developed epigastric distress cyanosis and an irregular pulse attributed to extra systoles of the heart. His temperature rose to 103 degrees. Examination revealed a rigidity of the abdominal muscles some involuntary spasms of the left thigh muscles and slight difficulty in opening the mouth. There was a bilateral Kernig sign present with hyperirritability and some nuchal rigidity. Tetanus antitoxin was administered intramuscularly intravenously and intraspinally so that in the first 24 hours he received 125 000 units of antitoxin. His general condition however became worse and with the development of signs of pneumonia he died 36 hours after the first symptom of tetanus appeared. The specimen was reported as a fibro adenoma of the prostate with areas of squamous cell metaplasia. The postmortem examination showed that the prostatic bed was hemorrhagic and black and that it contained a small amount of purulent material. The periprostatic tissues were indurated. The ejaculatory ducts as well as the seminal vesicles were filled with pus. Cultures from the bed showed the following organisms: (1) *Staphylococcus aureus* (2) *Streptococcus hemolyticus* B (3) diphtheroid bacilli and (4) *Bacillus proteus*.

CASE 3. R. C. aged 60 years male was subjected to a bilateral vasectomy and suprapubic cystostomy January 24 1934 for hypertrophy of the prostate. February 4 1934 a second stage prostatectomy was performed under spinal anesthesia. The entire prostate was removed in one piece and one thromboplastin soaked packing was inserted into the prostatic bed. Three chromic sutures were used to approximate the separated fascia. On the first day after operation the temperature rose to 101.8 degrees and came down to 99 degrees the following day. Five days after operation the packing was removed from the prostatic bed. The next morning his general condition appeared to be excellent and he had had a normal temperature for 3 days. On the afternoon of the sixth day he complained that his tongue felt thick. There was no dysphagia no trismus and a careful neurological examination revealed no abnormalities. However on the suspicion that this thick sensation of his tongue might be an early symptom of tetanus he was given 1500 units of tetanus antitoxin intramuscularly. The following morning distinct trismus was present. He was immediately given 40 000 units of tetanus antitoxin intraspinally 40 000 units intravenously and 20 000 units intramuscularly. The posterior urethra was irrigated with peroxide and he was given sedatives liberally. Despite this therapy he developed generalized twitchings a few hours later. During the first 24 hours he was given 150 000 units of tetanus antitoxin by the routes mentioned. His general condition rapidly grew worse his blood pressure fell to 83/60 and his urinary output dropped. He died 36 hours after the onset of trismus with signs of bronchopneumonia. In all 245 000 units of tetanus antitoxin had been given. The specimen showed typical fibro adenoma of the prostate with areas of acute inflammation.

The postmortem examination showed a bronchopneumonia of both lower lobes. The liver myocardium and kidneys showed severe degeneration. The right and left ventricles were dilated. The sinus tract which surrounded the drainage tube going into the bladder was free from edema and hemorrhage and showed no exudate. The smears from the sinus tract showed no organisms. The kidneys and ureters were not abnormal. The bladder showed evidences of trauma in the region of the prostatic urethra trigone and adjacent bladder wall with congestion and denudation of the mucosa. Smears from the exudate in the prostatic bed showed a single spore bearing bacillus after prolonged search. Culture of this exudate yielded *Bacillus welchii* but no tetanus bacilli and the guinea pigs inoculated did not develop tetanus.

This case is an example of fulminating clinical tetanus. At postmortem examination, *Bacillus welchii* was isolated from the prostatic bed while tetanus bacilli was not. The difficulties of finding the latter organisms in wounds of patients with tetanus are well known. In retrospect one may conjecture as to the possible recovery of this patient were he given large doses of antitoxin immediately on the complaint of thickness of his tongue. He was given 1500 units merely as a compromise because the possibility of tetanus was entertained. His general condition was so good at the time that one could hardly have foreseen a fatality in less than 48 hours. This case also emphasizes the difficulty of recognizing tetanus before the more classical symptoms develop.

air bubbles Smears and cultures are immediately made, and a positive spread is followed by the early institution of active therapy to combat the infection The wound is split wide open, tubes and catheters are placed into the depths for continuous irrigation with peroxide and oxygen, large quantities of polyvalent perfringens serum are administered intramuscularly, locally, and even intravenously. The patient is isolated and given individual nursing care Daily smears and cultures are made from wound Blood cultures are taken, if the temperature is high Intravenous fluids and blood transfusions are used as necessary.

When the infection subsides, Dakin solution may be alternated with the peroxide irrigations to hasten the separation of necrotic tissue and to stimulate granulation of the wound The early recognition and intensive treatment, as outlined, will be followed by a rapid subsidence of the infection and its concomitant symptoms We have not had a fatality that has been due directly to the *Bacillus welchii* infection in our last 9 cases

X-ray therapy (18) has recently been advocated for gas bacillus infections, but we ourselves have had no experience with it. This type of therapy may be of value, especially with the measures mentioned

The early recognition of tetanus is a more difficult matter General symptoms signify late manifestations of the disease. The appearance of the wound is of no aid in the diagnosis It might be of help to suggest that any unexplainable neurological symptoms must take into consideration the possibility of tetanus Our first case was recognized only after trismus appeared The second (G K) developed abdominal rigidity and spasms of the muscles of the left thigh In the third case (R. C), the diagnosis of tetanus was suggested, and treatment begun, on the mere complaint of "thickness" of the patient's tongue The mortality in tetanus is appalling Any hope of combating the complication is dependent upon early diagnosis and the administration of large doses of tetanus antitoxin by all routes It might be well to use a very large dose such as is given in the treatment of diphtheria and then to follow its administration with repeated smaller doses The wound should be exposed and irrigations with peroxide should be carried out In addition to this, adequate sedation and supportive therapy should be carried out as required

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SUMMARY OF THE CASES IN TWO GROUPS

Case	Disease	Operation	Organism	Result
8 L B	Tuberculosis of the kidney right	Nephrectomy	B. welchii	Died
5 S L	Tuberculosis of the kidney right	Nephrectomy	B. welchii	Well
4 H S H	Tuberculosis of the kidney right	Nephro-ureterectomy	B. welchii	Well
3 A E R	Renal calculus right	Pyelotomy and nephrotomy	B. welchii	Well
6 R W	Renal calculus right	Nephrectomy	B. welchii	Well
2 L B	Renal neoplasm right	Nephrectomy	B. welchii	Well
11 F M	Ureteral calculus	Ureterolithotomy	B. welchii	Died
9 E A R	Ureteral calculus	Ureterolithotomy	B. welchii	Well
7 A L	Renal cysts left	Apyclation and excision	B. welchii	Well
10 G W K	Prostatic hypertrophy	First stage cystostomy	B. welchii	Died
1 A R	Prostatic hypertrophy	Second stage prostatectomy	B. welchii	Died
3 L H	Prostatic hypertrophy	Second stage prostatectomy	B. tetani	Died
2 G H	Prostatic hypertrophy	Second stage prostatectomy	B. tetani	Died
1 R C	Prostatic hypertrophy	Second stage prostatectomy	B. tetani	Died

Four out of 11 cases of *Bacillus welchii* infection died (36.3 per cent mortality). Three out of 3 cases of *Bacillus tetani* infection died (100 per cent mortality).

If we are to interpret our mortality figure correctly as those due directly to infection by *Bacillus welchii* we should exclude 2 deaths (G W K died 5 weeks later due to puerperal sepsis; uremia and thrombophlebitis A R died 4 weeks later due to hemorrhage) which occurred long after the infection was controlled. In that event the correct mortality to *Bacillus welchii* infection in this series is 2 per cent.

for the migration of organisms from the right colon to the right kidney. Stahr by microscopic and injection studies demonstrated the connection between the lymphatics of the capsule of the kidney, with the renal parenchyma and pelvis. Hutchison feels that bacteria may pass from the bowel to the kidney by way of the lymphatics when lesions of the bowel are present. He cites a case in which an appendix was adherent to the kidney and the *Bacillus coli* was found in the urine.

From this discussion it is readily conceivable that anaerobic infections may follow operations on the urinary tract due to the incidental presence of these organisms in the urinary organs. It is also of interest to note, in view of the discussed relationship of the right colon to the right kidney, that 7 out of our 9 cases of anaerobic infection of the suprapubic region occurred on the right side. The question arises as to whether during the mobilization of the kidney and ureter one may not open lymphatics from the bowel in the stripping away of the peritoneum and thus allow organisms to enter the traumatized retroperitoneal area. From this standpoint cultural studies of the urine before and after operation in uninfected kidney and ureter cases may be of value.

Ferrier and Bliss were the first to isolate *Bacillus welchii* from the center of a renal calculus in a patient who developed gas gangrene of the operative wound. With this possibility in mind 36 urinary calculi have thus far been studied at Mt

Sinai Hospital. The outside of the stone was first thoroughly flamed and the calculus was then crushed with a sterile instrument and cultured. This was controlled by crushing fragments of sterile sand. In calculi from 3 different patients the *Bacillus welchii* was isolated. Fortunately these patients did not develop wound infections. It is possible that should these organisms be present in a calculus, the crushing of the stone during its delivery might play a part in postoperative anaerobic infections.

DIAGNOSIS AND TREATMENT

The prognosis in this type of infection is directly dependent upon early recognition and adequate treatment. Any patient who has had an inordinate rise in temperature, with or without symptoms of toxemia, should receive a careful inspection of the wound in addition to a general physical examination. Especially is this important within 48 hours after operation, during which time many surgeons are apt to look for other sources of trouble than wound infection and attribute the elevated temperature to a few ribs in the lungs or to postoperative reaction. Discoloration, edema, or crepitation in the region of the wound calls for further investigation of the depths. Crackling may be heard by applying firm pressure with the stethoscope against the involved area in which gas is present. Under these circumstances, we do not hesitate to remove superficial and deep sutures, watching for serum, pus and

air bubbles Smears and cultures are immediately made, and a positive spread is followed by the early institution of active therapy to combat the infection The wound is split wide open, tubes and catheters are placed into the depths for continuous irrigation with peroxide and oxygen, large quantities of polyvalent perfringens serum are administered intramuscularly, locally, and even intravenously The patient is isolated and given individual nursing care Daily smears and cultures are made from wound Blood cultures are taken, if the temperature is high Intravenous fluids and blood transfusions are used as necessary.

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EDITORIALS

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THE VALUE OF DETERMINATIONS OF PROTEIN PRIOR TO OPERATIONS ON THE GASTRO-INTESTINAL TRACT

ALTERATIONS in the protein of the blood serum have heretofore been of greater interest to the internist than the surgeon. Recent observations, however, indicate that estimations of the serum proteins and of the colloid osmotic pressure which they exert may be of equal value in the surgical management of gastro intestinal lesions.

It is well known that the serum proteins usually are lowered in cases of edema resulting from an inadequate intake of protein, from inadequate absorption from the gastro intestinal tract of ingested protein, or from excessive loss of protein in the urine. "War edema," "prison dropsy," and the anasarca that so often occurs in sprue, certain diarrheas and nephrosis, are examples of foregoing processes. Hypoproteinemia in certain diseases of the

liver is well known, and here again the low level of serum protein often is intimately related to the formation of edema and ascites.

From this one can assume that edematous changes can and do occur in the tissue of individuals with hypoproteinemia. All investigators are agreed on the importance of the pull of the plasma colloids on the control of the fluid balance between blood and tissue. The force exerted by the plasma proteins tends to absorb fluid from the tissue spaces, while capillary pressure, on the contrary, tends to force fluid from the blood stream into the tissue spaces. Thus, theoretically, the relative constancy of blood volume and tissue fluid volume should depend primarily upon a balance between these two forces.

It has been repeatedly demonstrated that generalized edema develops in animals fed diets deficient in protein, ulcers in the stomach and duodenum may also appear (Hoelzel and Da Costa, 1937). In addition it has been shown experimentally that hypoproteinemia in normal dogs is accompanied by a decreased gastric emptying time, and that dogs which have undergone pyloric resection, with restoration of gastro intestinal continuity by various standard methods, show the same delay in gastric emptying time when the serum proteins are decreased by a diet deficient in protein and by plasmapheresis. Fluoroscopic examination of the stomachs of these animals presents a picture difficult to distinguish from that observed during anatomical obstruction (McCray, Barden, and Ravdin, 1937). At necropsy, these animals show definite edema of the gastro intestinal tract. This water logged type of mucosa has also been observed in the intestinal tract of man.

Moreover, it has been observed that an inadequate intake of food may produce defects in the gastro-intestinal tract of man (Jones and Eaton, 1933), and recently it has been reported that a reduction in the plasma proteins after a gastro-intestinal operation is accompanied by a deformity of the stoma which resembles in every way a real anatomical defect as seen roentgenologically. Such defects, according to Barden, Ravdin, and Frazier (1937), are said to disappear when the serum proteins are raised to a normal level. These authors suggest that the presence of edema in the mucosa reduces the size of the stoma and so interferes with emptying of the viscus. The observed retention might conceivably result from decreased gastric activity or defective muscular contraction, but these investigators favor the view that local edema is responsible.

The desirability of determining the serum proteins in cases in which gastric emptying is delayed, either before or after operation, is obvious. It is well to remember, however, that estimation of total protein is not always an accurate indication of the effective osmotic pressure. Even with pure protein solutions the colloid osmotic pressure is not linearly related to the concentration of protein but tends to increase per gram of protein as the total protein concentration is increased. The converse of this is also true. A satisfactory theoretical explanation of this relation between concentration of protein and the colloid osmotic pressure is not known. However, this fact should be clearly understood and always considered when studying pathological serums. In such cases a better but still imperfect relation can be obtained by analysis of the proteins as albumins and globulins (Butt and Keys, 1937).

Certainly, in view of these recent contributions, the possibility of hypoproteinemia and

edema of the gastric mucosa must be considered in cases in which there is clinical and roentgenological evidence of pyloric or stomal obstruction. It is, of course, well known that non-functioning stomas begin normal function without any type of treatment other than gastric aspiration. Often the administration of saline or glucose solutions to the patients will be followed by a decrease in the observed gastric retention. The explanation for this phenomenon is not entirely clear, but certainly it is not the result of increasing the colloid osmotic pressure. If the protein values are low, however, an attempt ought to be made to increase them by transfusion and a high protein diet if standard methods prove ineffective.

HUGH R. BUTT

THE ANTISEPTIC ERA

THE antiseptic era has been marked by an interesting paradox. Pasteur was responsible perhaps for the fact that surgeons have been overapprehensive regarding germ infection. Lister, on the other hand, may be charged with having inspired in the hearts of most surgeons a greatly exaggerated overconfidence in the value of chemical antiseptics. Careful reading of the works of both Pasteur and Lister will indicate, however, that they appreciated, as few of their followers have done, the importance of inherent immunity and bodily resistance against invasion by micro-organisms.

On more than one occasion Lister called attention to the fact that much of the successful surgery done before his time was due to the ability of the body to overcome infection. Lister's original proposal was not to combat infection by means of carbolic acid but to employ carbolic dressings for the purpose of excluding micro-organisms from wounds. That Lister has been generally misunderstood on this point is indicated in much of the litera-

ture of wound treatment and antiseptics. In his recent autobiography¹ Dr Robert T Morris says

It was some twenty years later that Lister introduced his theory of air infection and with the backing of Pasteur developed his antiseptic method of wound treatment. Von Bergmann in 1892 went a step farther and introduced asepsis. This theory developed by Schimmelbusch showed that it was more important to prevent the entrance of microbes into the operative field than it was to destroy them after they had gained entrance. The von Bergmann principle of holding microbes at a distance quickly succeeded the Listerian idea though founded upon it.

The thousands of attempts that have since been made both upon patients and in the laboratory to discover a chemical specific for infected wounds have led to much confusion in surgical practice. These attempts, also, have caused many surgeons to lose sight of the importance of supporting the patient in every possible way and of building up his bodily resistance to infection. Likewise too little has been done in the direction of protecting the patient from outside influences and of helping him to defend himself against invasion by septic micro organisms. This, in spite of Lister's specific injunction on this point. Some of the most recent successes in the field of surgery have resulted from a better perception of this important truth. Urologists, by their recent work in prostatic surgery, have, for example, called our attention again to the importance of building up the patient with fluids, of providing drainage for infected blad-

ders and kidneys, and of balancing intake and output in body metabolism before resorting to surgical procedures. They have thereby very greatly improved their surgical results.

The influence of physiological rest in the treatment of all kinds of acute and chronic infections may now be employed similarly to conserve the resources of the patient. In fractures and other injuries with infection it is of paramount importance to protect him against improper movement and muscle spasm and to contribute to his own ability to resist infection. Immobilized in correct position and at rest, with nerves and circulation able to function efficiently, he can employ his own healing powers in co-operation with the surgeon to bring about a cure.

Very little is still known about the actual chemistry either of infectious processes in wounds or in the body or of the underlying processes of immunity or resistance. Those physiological processes that we do know more about should be employed in every way until chemical specific treatment may be better understood and others added to the very short list of really useful antiseptics now available. So many laboratory experiments have been unintelligently applied to human beings without any reasonable prospect of success, and so many have been exploited even when their failure was foredoomed that an adherence to first principles would seem to be demanded if we are to give our patients the benefit of best surgical practice.

H. WINNETT ORR

¹ See Robert T. Morris, *My Years as a Surgeon*, p. 67. New York: E. P. Dutton & Co., Inc., 1937.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE fifth edition of the popular English *Textbook of the Practice of Medicine*,¹ a compilation of several well known English physicians, contains many additions and revisions since the last edition 4 years ago. Among these are, a discussion of such topics as total thyroidectomy in congestive heart failure, oxygen therapy in anoxemia, the use of mandelic acid in pyelitis, and a good up-to-date discussion of the treatment of amebic dysentery.

The text contains nearly 1900 pages exclusive of the index. The latter is complete. There are 112 illustrations, many of which are of electrocardiograms. Additions have been made to the section on psychological medicine, and the section devoted to diseases of the nervous system has been largely revised. No bibliography is included.

This book contains an enormous amount of material, and is as complete as a text covering so many phases of medicine can be. Its popularity attests to the fact that the editor has been successful in compiling a work which is of service to the student, teacher, and practitioner of medicine.

J. ROSCOE MILLER

GRAY presents in a most readable, enjoyable, and instructive diary² form the daily life of a medical student in London two hundred years ago. The crowded wards, emergency operations, puerperal fevers, anatomy classes with body snatching, treatment of criminals, and street brawls pass most interestingly through the pages. The last half of the book portrays the picture of life on shipboard with its scurvy, harsh discipline, and emergency treatment of battle injured seamen. While the book should not be regarded as an authentic diary it can be warmly recommended for the doctor's leisure hour.

THE fact that the bodily balance in accord with the principles of mechanics is a means for conservation of nervous energy is discussed and developed from an anatomical, physiological and mechanical point of view by Todd in her recent work, *The Thinking Body*.³ A full chapter is devoted to breathing and another to locomotion. Emphasis is placed upon the conception that the emotional aspect of behavior finds an expression in the body posture.

¹ A TEXTBOOK OF THE PRACTICE OF MEDICINE. By various authors. Edited by Frederick W. Price, M.D., C.M., F.R.C.P., F.R.S., (Edin.) 5th ed. New York and London: Oxford University Press, 1937.

² THE DIARY OF A SURGEON IN THE YEAR 1751-1752. By John Kniveton. Edited and transcribed by Ernest Gray. New York and London: Appleton-Century Co., 1937.

³ THE THINKING BODY, a Study of the Balancing Forces of Dynamic Man. By Mabel Elsworth Todd. Foreword by E. G. Brackett, M.D. New York and London: Paul B. Hoeber, Inc., 1937.

As is stated in the foreword, "New views, even though correct, find their place in the community but slowly; the author of this book, however, has a large amount of material to substantiate her claims for her methods, and she has given this to the public only after long and practical experience, the results of which demonstrate the soundness of her views."

EMIL HAUSER.

NO BOOK that I have thus far read so adequately covers the field of abdominal surgery in children as that by Sir Lancelot Barrington-Ward, the new second edition⁴ of which is now being published by the Oxford University Press of London.

Following a discussion of the general principles of surgery, the author takes up in order: the congenital defects of the abdominal wall; hernia and undescended testis, hydrocele; hematogenous peritonitis; abdominal peritoneal tuberculosis, congenital hypertrophic pyloric stenosis; appendicitis and its complications, diseases of the gall bladder, pancreas and spleen, intestinal obstruction of various types with special emphasis on intussusception, errors in the development of the intestinal tract (especially Meckel's diverticulum), Hirschsprung's disease; mesenteric cysts, and, finally, a brief discussion of anesthesia in children and intravenous therapy.

Each topic is thoroughly and completely discussed in a manner most pleasing to read, and evidencing a broad knowledge of general surgery by the author. The book is very well illustrated with excellent photographs, accurate drawings, clear x-ray films, and a few beautiful color plates. For any one interested in obtaining the latest and most complete book in the field of abdominal surgery in children I cannot too strongly recommend this volume.

EDWIN M. MILLEP

IN *The Management of the Pneumonias*,⁵ by Dr. Bullowa, an enthusiastic author well known in American medical literature on the subject of oxygen therapy and pneumonia treatment, Oxford University Press presents a monograph of 508 pages, characteristically well printed on good paper. Many of the illustrations are not up to the standard of the rest of the volume. The first 75 pages are given to a discussion of classification, course, diagnosis, symptoms and physical findings of pneumonia. The section on the laboratory examination is well illustrated

⁴ THE ABDOMINAL SURGERY OF CHILDREN. By Sir Lancelot Barrington-Ward, K.C.V.O., Ch.M., F.R.C.S. (Edin.), F.R.C.S. (Eng.) 2d ed. London: Oxford University Press, 1937.

⁵ THE MANAGEMENT OF THE PNEUMONIAS; for Physicians and Medical Students. By Jesse G. M. Bullowa, B.A., M.D. New York: Oxford University Press, 1937.

ture of wound treatment and antiseptics. In his recent autobiography¹ Dr Robert T Morris says

It was some twenty years later that Lister introduced his theory of air infection and with the backing of Pasteur developed his antiseptic method of wound treatment. Von Bergmann in 1892 went a step farther and introduced asepsis. This theory developed by Schimmelbusch showed that it was more important to prevent the entrance of microbes into the operative field than it was to destroy them after they had gained entrance. The von Bergmann principle of holding microbes at a distance quickly succeeded the Listerian idea though founded upon it. (1)

The thousands of attempts that have since been made both upon patients and in the laboratory to discover a chemical specific for infected wounds have led to much confusion in surgical practice. These attempts, also, have caused many surgeons to lose sight of the importance of supporting the patient in every possible way and of building up his bodily resistance to infection. Likewise too little has been done in the direction of protecting the patient from outside influences and of helping him to defend himself against invasion by septic micro-organisms. This, in spite of Lister's specific injunction on this point. Some of the most recent successes in the field of surgery have resulted from a better perception of this important truth. Urologists, by their recent work in prostatic surgery, have for example called our attention again to the importance of building up the patient with fluids, of providing drainage for infected blad-

ders and kidneys, and of balancing intake and output in body metabolism before resorting to surgical procedures. They have thereby very greatly improved their surgical results.

The influence of physiological rest in the treatment of all kinds of acute and chronic infections may now be employed similarly to conserve the resources of the patient. In fractures and other injuries with infection it is of paramount importance to protect him against improper movement and muscle spasm and to contribute to his own ability to resist infection. Immobilized in correct position and at rest with nerves and circulation able to function efficiently, he can employ his own healing powers in co operation with the surgeon to bring about a cure.

Very little is still known about the actual chemistry either of infectious processes in wounds or in the body or of the underlying processes of immunity or resistance. Those physiological processes that we do know more about should be employed in every way until chemical specific treatment may be better understood and others added to the very short list of really useful antiseptics now available. So many laboratory experiments have been unintelligently applied to human beings without any reasonable prospect of success, and so many have been exploited even when their failure was foredoomed that an adherence to first principles would seem to be demanded if we are to give our patients the benefit of best surgical practice.

H WINNETT ORR

¹For Dr Robert T. Morris: *Twenty Years a Surgeon*, p. 67. New York: E. P. Dutton & Co. Inc. 1937.

ever, where we are still far from standardization of opinion concerning many questions. The technique of treatment for each condition is outlined in great detail, so as to give the radiotherapist a schedule of treatment for each lesion mentioned.

The discussion is executed from the point of view of a clinician, in so far as clinical considerations have entered the field very extensively. A small but precise summary as to diagnosis, the surgical indications, the pathology as far as this is necessary for clinical understanding and for radiologic indications always precedes the discussion of the radiation therapy. In this way the book provides a convenient guide for the general practitioner and for the student as to the possibilities and indications of radiation therapy. At the same time, it gives to the radiologist a schematic outline of the technical procedure recommended which will be useful for those who know how to adapt this scheme carefully to the individual case to which they wish to apply it.

MAX CUTLER

PRACTICAL NEUROANATOMY,¹ by J. H. Globus, is the outgrowth of an earlier laboratory guide-book for "study of the form and internal structure of the brain and spinal cord" which went through six editions. The original form and contents have not been changed greatly but much material has been added. There are now 256 pages of text as compared with 121 pages in the previous book. The increase results principally from the addition of two new sections devoted to résumés of the author's lectures to his students and to neurological technical methods. The main portion of the text is arranged in 25 "assignments" containing directions for the day by day study of the nervous system, questions intended to stimulate students' thought and brief descriptions of the structures encountered in the laboratory material. Following an embryological introduction, the reader is led to consider the external and internal anatomy of the cerebrum, corpus striatum, spinal cord and brainstem but is not introduced to the cellular elements of the nervous system until the last few pages.

Although the book has been vastly improved in its present form, it still seems to the reviewer that it possesses some unfortunate features. Can the student profit by studying the internal anatomy of the brain before examining nerve cells and fibers? Can he be expected to discuss intelligently and profitably "nuclei, their morphology and functional types and tracts, their make-up and varieties" in the first assignment when he is unacquainted with the fundamentals of nervous tissue?

The illustrations of the text have been improved and made usable by the addition of labels with guide lines. Their number has been increased from 36 to 92 in this edition. Some could be improved still more by judicious addition of a few more labels and

by increasing the magnification especially in the case of the higher brainstem photographs. A very commendable feature is found in the use of diagrams of truncated brainstems accompanying the photographs of sections to give the student a three-dimensional conception of the intrinsic structures. The diagrams are adequate throughout the lower part of the medulla oblongata but, unfortunately, the illustrator seems to have been somewhat confused in his representation of the levels at the junction of the medulla oblongata and pons, Figure 52, in particular, is very misleading.

There are several good textbooks of neuroanatomy available but any new one with real improvement in the methods of teaching the subject or with successful digestion of the many new facts which are accumulating so rapidly will be most welcome. This book does offer a fresh method of study and probably fills a real need for the author's course. It does not contain much new information and will consequently prove to be less useful to advanced students and clinical readers than could be hoped for.

WILLIAM F. WINDLE

DISEASES of veins are less well understood than are those of other systems. That this is so is perhaps due to the neglect of the venous system by the physiologists. Franklin's very scholarly *Monograph on Veins*² attempts to overcome this lack. According to the author, it is the first treatise of its kind in English, and has only two predecessors in other languages. This volume, which encompasses the author's own investigations as well as an exhaustive compilation of the literature, is concerned essentially with the physiology of veins, although embryology and anatomy are also discussed. The veins assume an important rôle in the circulatory mechanism. They do not function merely as passive channels for the return of the blood to the heart, but actively regulate the volume of circulating blood and the cardiac output. Propulsion of blood within the veins is effected by means of their intrinsic neuromuscular mechanism and by virtue of external forces acting upon them. The author points out that the data concerning various phases of vein physiology are sometimes conflicting and often incomplete.

It is to be regretted that pathological physiology and its effects upon the other tissues of the body have not been included in this monograph, and that the clinical phases of the subject are compressed into a single chapter where, for the most part, they receive rather superficial treatment. While this book will not be of immediate practical assistance to the clinician confronted with diseases of the veins, it will be invaluable to the student of the venous system. The digest of the literature and the very extensive bibliography should provide the starting point for future work, and will, perhaps, engender the clinical monograph on veins, for which the physician has been waiting.

LEO M. ZIMMERMAN.

¹PRACTICAL NEUROANATOMY, a Textbook and Guide for the Study of the Form and Structure of the Nervous System. By J. H. Globus, B.S., M.D. Baltimore: William Wood & Co., 1937.

²A MONOGRAPH ON VEINS. By Kenneth J. Franklin, D.M., M.P.C.P. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

and clearly written. The author's experience with the typing and administration of serum with its advantages and disadvantages is well brought out.

Oxygen therapy which is the second great advance in the modern management of pneumonia is very well presented. An aggressive attitude is assumed in the adequate administration of 3000 to 3500 cubic centimeters of fluid and as many calories of food. Unfortunately, no adequate rule is presented for the administration of sodium chloride, nor is the over dosage of sodium chloride with formation of edema in the lung, warned against. Wisely 'codeine in adequate doses is given and morphine is rarely given' since it 'greatly depresses all receptors and the respiratory center, slowing respiration and diminishing the cough reflex. It does not greatly depress cerebral activity and it should never be used as a nervous sedative in pneumonia though it may be used for very severe pain in a dose of gr 1/6'. Digitalis is not used by the author since heart failure as such rarely exists.

In the main the book is very well done and the author is entitled to his particular opinions. However, such a comment as 'nasal catheters' are not advised will not be well received by that number of men who are well acquainted with their use in everyday practice where other methods are not suited or not available. It occurs to me that the volume might have been called 'The Treatment of Pneumonia at Harlem Hospital' rather than the broad title 'The Treatment of the Pneumonias'.

M HERBERT BARLER

THE merit of the monograph entitled *Arteriovenous Aneurysm*¹ by Holman is attested to by the fact that it was awarded the 1930 quinquennial Samuel D. Gross Prize by the Philadelphia Academy of Surgery.

The context is presented in a rather unique manner. The first chapter is devoted to experimental work which gives the reader a very clear conception of the pathologic physiology of arteriovenous fistulas. The author then discusses at length acquired arteriovenous communications of the extremities, intra-thoracic fistulas, mycotic arteriovenous aneurysms and the various congenital arteriovenous communications. The last 100 pages of the book are devoted to case reports and protocol of experiments. A liberal bibliography is appended.

The treatise will prove interesting to those men who have been faced by the difficulties which are met with in the surgical management of these lesions. It will be very useful to teachers because it assembles most of the facts relative to this unusual lesion. The author makes an interesting survey of the early literature dealing with arteriovenous communications and supplements this by frequent references to the work of his contemporaries. The book is a scholarly effort and should be read by a great

many who might be dissuaded from doing so because of its rather stiff pedagogic style. As a reference book it will prove valuable to internist and surgeon but its value as a technical guide in the surgical management of these lesions is limited. The volume may properly serve as a source book for future work in this field.

R W McNEALY

THERE has long been a need for a textbook on radiation therapy. The reason for this gap is obviously because of the enormous difficulty in formulating standardized conclusions such as those required of a textbook in a field still in a stage of rapid development. We can therefore be grateful to Dr Kaplan that he has undertaken the task of giving in a precise and comprehensive manner a convenient survey of the possibilities, the indications and the limitations of radiation therapy in all phases of clinical medicine including benign and malignant conditions.²

After a brief historical introduction and a discussion of radiation biology the physics of radiation and of electrosurgical currents are discussed. The chapter on x ray physics is written by C B Braestrup. In these chapters the authors give a convenient survey of the different types of apparatus most commonly used today in modern radiation institutes.

Following the basic chapters of about 100 pages the application of radiation therapy in all its different forms is discussed for the fields of dermatology, ophthalmology, ear nose and throat conditions, thoracic lesions, breast lesions, gastro-intestinal, gynecologic, genito-urinary, and neurologic conditions as well as endocrinology. In all these chapters the benign as well as the malignant lesions are considered. Following the discussion of radiation in the different specialties, there are some chapters dealing with irradiation of special pathologic conditions such as different forms of tuberculosis, osteomyelitis and gonorrheal arthritis, specific diseases of the reticulo-endothelial system, blood dyscrasias, soft tissue sarcomas and bone conditions. The later chapters are devoted to the complications and injuries following irradiation to traumatic cancer and to the nursing care of patients with malignant conditions. In the final chapter a model organization for a radiation therapy department is outlined.

In covering this enormous field in a textbook of this kind the discussion naturally has to be limited to the most outstanding features of each type of lesion and the discussion covers the different phases with differing degrees of thoroughness. Regarding the type of treatment recommended the discussion is based entirely on the author's own extensive experience and the methods used elsewhere are only casually mentioned. Obviously, this gives the book all the advantages and the disadvantages of a subjective and arbitrary discussion by an author who has worked many years in this field in a field hospital.

¹ARTERIOVENOUS ANEURYSM. ABNORMAL COMMUNICATIONS BETWEEN THE ARTERIAL AND VENOUS CIRCULATIONS. By Emil Holman. B A B A (Oxon) M D. New York: The Macmillan Co. 1935.

²RADIATION THERAPY. ITS USE IN THE TREATMENT OF BENIGN AND MALIGNANT CONDITIONS. By I. Kaplan. B Sc, M D. New York: Oxford University Press. 1937.

BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SURGICAL DISEASES OF THE MOUTH AND JAWS By Earl Calvin Padgett B.S. M.D. F.A.C.S. Philadelphia and London W. B. Saunders Co. 1938

APPROVED LABORATORY TECHNIC CLINICAL PATHOLOGICAL BACTERIOLOGICAL MYCOLOGICAL PARASITOLOGICAL, SEROLOGICAL BIOCHEMICAL AND HISTOLOGICAL By John A. Kolmer M.D. Dr.P.H. Sc.D. LL.D. L.H.D. F.A.C.P. and Fred Boerner M.D. 2d ed. New York and London D. Appleton Century Co. Inc. 1938

TEXTBOOK OF EXPERIMENTAL SURGERY By J. Markowitz M.B. (Tor.) Ph.D. M.S. in Exp. Surg. (Minn.) Baltimore William Wood & Co. 1937

TRANSACTIONS OF THE FIFTY EIGHTH MEETING OF THE AMERICAN SURGICAL ASSOCIATION Vol. 55. Edited by Walter Estell Lee M.D. Philadelphia J. B. Lippincott Co. 1937

THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY. Supplement—Index New York and London D. Appleton Century Co., Inc. 1938

MACLEOD'S PHYSIOLOGY IN MODERN MEDICINE Edited by Philip Bard et al. 8th ed. St. Louis The C. V. Mosby Co., 1938

SPEECH TRAINING FOR CASES OF CLEFT PALATE By M. C. Oldfield M.Ch. (Oxon.) F.R.C.S. London H. K. Lewis & Co. Ltd. 1938

NATIONAL MEDICAL MONOGRAPHS. DISEASES OF WOMEN FOR THE GENERAL PRACTITIONER By Paul Tish M.D. Edited by Morris Fishbein M.D. New York National Medical Book Co. Inc. 1937

THE PHYSICIAN'S BUSINESS. PRACTICAL AND ECONOMIC ASPECTS OF MEDICINE By George D. Wolf M.D. Foreword by Harold Rypins A.B. M.D. F.A.C.P. Philadelphia and London J. B. Lippincott Co. 1938

MILESTONES IN MEDICINE. LATTY LECTURES OF THE NEW YORK ACADEMY OF MEDICINE Introduction by James Alexander Miller M.D. New York and London D. Appleton Century Co. Inc. 1938

THEORETICAL PRINCIPLES OF ROENTGEN THERAPY Edited by Ernst A. Pohle M.D. Ph.D. F.A.C.R. Foreword by W. Edward Chamberlain B.S. M.D. F.A.C.R. Philadelphia Lea & Febiger 1938

OPERATIVE GYNECOLOGY By Harry Sturgeon Crossen M.D. and Robert James Crossen, M.D. 5th ed. St. Louis The C. V. Mosby Co. 1938

TEXTBOOK OF OPHTHALMOLOGY By Sir W. Stewart Duke Elder M.A. D.Sc. (St. And.) Ph.D. (Lond.) M.D. Ch.B. F.R.C.S. Vol. 2—Clinical Methods of Examination Congenital and Developmental Anomalies General Pathological and Therapeutic Considerations Diseases of the Outer Eye. St. Louis The C. V. Mosby Co. 1938

COLLECTED PAPERS ON TUBERCULOSIS By Sir Robert W. Philip M.A. M.D. LL.D. F.R.C.P. (Hon.) F.R.C.S.E. F.R.S.E. London Oxford University Press 1937

A PRACTICE OF ORTHOPAEDIC SURGERY By T. P. McMurray M.B. M.Ch. F.R.C.S. (Edin.) Baltimore William Wood & Co. 1937

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS By Edwin O. Geckeler M.D. Baltimore William Wood & Co. 1937

ILLNESS: ITS STORY AND SOME COMMON SYMPTOMS. A GUIDE FOR THE LAYMAN By S. Henning Deurance M.D. (Lond.) London Oxford University Press 1938

THE COMPLETE PEDIATRICIAN. PRACTICAL DIAGNOSTIC THERAPEUTIC AND PREVENTIVE PEDIATRICS FOR THE USE OF MEDICAL STUDENTS. INTERNES. GENERAL PRACTITIONERS AND PEDIATRICIANS By Wilbur C. Davison M.A. D.Sc. M.D. 2d rev. ed. Durham N.C. Duke University Press 1938

A HISTORY OF WOMEN IN MEDICINE FROM THE EARLIEST TIMES TO THE BEGINNING OF THE NINETEENTH CENTURY By Kate Campbell Hurd Mead M.D. Haddam Conn. The Haddam Press 1938

ULCER GASTRO-DUODENAL PERFORADA By Dr. Marcelo J. Verengo Buenos Aires Liberia y Editorial El Ateneo 1937

THE PATIENT AND THE WEATHER By William F. Petersen M.D. With the assistance of Margaret E. Milliken S.M. Volume IV Part 3—Organic Disease. Surgical Problems. Ann Arbor Mich. Edwards Bros. Inc. 1935

CORRESPONDENCE

THIRD INTERNATIONAL CANCER CONGRESS

THE Third International Cancer Congress under the auspices of the International Union against Cancer will be held in the United States September 11 to 16 1939 at the Haddon Hall Hotel Atlantic City New Jersey.

The president of the congress is Professor Francis Carter Wood director of the Institute of Cancer Research of Columbia University, New York City. Dr. Donald S. Childs of Syracuse New York is the secretary treasurer and Dr. A. L. Loomis Bell of Long Island College Hospital Brooklyn New York is in charge of transportation and exhibits.

The proposed sections are as follows: General research biophysics genetics general pathology of cancer surgery of cancer radiological diagnosis of cancer radiotherapy of cancer statistics and education. Further details concerning section chairman committees and other data will be announced later.

The membership fee will be \$15. All inquiries regarding the Third International Cancer Congress should be addressed to the Institute of Cancer Research 1145 Amsterdam Avenue New York New York.

SURGERY

GYNECOLOGY AND OBSTETRICS

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INTUBATION STUDIES OF THE HUMAN SMALL INTESTINE

X. A Non-Surgical Method of Treating, Localizing and Diagnosing the Nature of Obstructive Lesions

W. OSLER ABBOTT, M.D., Philadelphia, Pennsylvania, CHARLES G. JOHNSTON, M.D.,
F A C S, Detroit, Michigan

SINCE the decline in the incidence of typhoid fever, intestinal obstruction has become the most lethal affection of the small bowel. Its local treatment consists of (1) reducing the distention of the gut proximal to the lesion, (2) locating and relieving the obstruction, and (3) excising any gangrenous tissue devitalized by a disturbance of its blood supply. Until recently operation was relied upon to accomplish these three ends, but the mortality in cases so handled has always been high. The studies of Wangenstein and Paine, however, have most clearly brought out the facts (a) that deflation of the stomach and, if possible, of the duodenum will often decompress the proximal small intestine, with a reduction in the mortality incident to subsequent operation, and (b) that, when the obstruction is due to kinking by adhesions and perpetuated by the distention itself, it may be permanently relieved by decompression

alone. However, a fairly large group of patients with obstruction remains in which gastroduodenal suction is not enough to relieve the distention and a still larger group in which, though the distention be relieved, the location, as well as the nature, of the obstructive lesion is still unknown. It is for these cases that we now offer a method of management that will often decompress the abdomen by completely emptying the entire small intestine proximal to the obstruction, and that has, in certain cases, enabled a restitution of normal intestinal action to occur without the necessity of surgical intervention. Moreover, having advanced the tube to the point of obstruction, it often becomes possible by the study of aspirated intestinal contents and by the injection of a minimal amount of an opaque medium through the tube to identify both the position and the nature of the obstructing lesion. Thus two of the three objectives of surgery may be met, but it can not be too strongly emphasized that the third indication remains and that whenever gangrene of the gut is suspected operation must continue to be the treatment of immediate choice.

From the Gastro-Intestinal Section, Kinsey-Thomas Foundation of the Medical Clinic, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, and the Department of Surgery, Wayne University College of Medicine and Receiving Hospital, Detroit, Michigan.
Aided by a grant from the Committee on Scientific Research of the American Medical Association.
Dr. Abbott, H. F. M. Kirby, Fellow in Surgical Physiology.



Sir William Jenner

1815 1898



Fig 1 Paralytic ileus Case 3, F F. a, left, Small intestinal distention 4 days after operation b, Decompression of the intestinal tract by the passage of a No 14 F tube for aspiration fastened to a No 3 F tube bearing an air-filled balloon

hour. A length of 6 to 8 feet of tubing is generally enough to reach from the pylorus to the cecum (8 to 10 feet beyond the teeth) In obstructed cases a rate of about 1 centimeter in 2 minutes (1 foot in an hour) is nearer the average. It is important that the tubes be marked at 6 inch intervals so that the patient or the nurse may be given a schedule to insure correct speed of swallowing, as a coil in the stomach from too rapid passage will sometimes check its advance

RESULTS

Intubation for the relief of intestinal obstruction has been attempted on 16 individuals with failure in only 3 While the symptoms in one or two instances were mild, the patients as a rule, were desperately ill In 9 instances function returned spontaneously following a variable period of decompression Paralytic ileus and organic obstructions have responded in an essentially similar fashion (Figs 1, 2, and 3) In the 4 cases in which the obstructing lesion was studied roentgenologically after the injection of a barium sulphate suspension through the tube, the point of closure was identified and the end of the tube was found to be lying within a finger's length of the obstruction itself (Fig 4)

As the severity of intestinal obstruction can vary so widely, depending on the attendant circumstances, a brief sketch of each case

follows The data bearing upon the technique employed are presented separately in a summary table

CASE REPORTS

Patients who became obstructed while under observation

CASE 1 J K, male, 73 years of age, with symptoms of chronic prostatism, became slowly obstructed by a carcinoma of the cecum Intubation was carried out while he was in a state of shock from pain, distention, and vomiting He was so relieved that he pulled the tube out later that night At that time the abdomen was flat, peristalsis was normal, and his general condition was good Subsequently, however, distention recurred and operation without intubation was attempted, but he died

CASE 2 W S, male, 42 years of age suffered a spontaneous rupture of a duodenal ulcer, was operated upon, and convalesced normally for 7 days Fever and great abdominal distention, accompanied by streptococcic septicemia, then developed rapidly with a disappearance of peristalsis The obstruction was of a paralytic type associated with infection Intubation carried him over the period of ileus and ultimately, when he was able to eat, the tube was withdrawn without a recurrence of the symptoms

CASE 3 F F, male, aged 68 years had undergone an exploratory laparotomy because of sudden weight loss and constipation His abdominal cavity was practically normal but the patient was in an agony of fear, believing that he was dying of cancer. His obstruction was of a paralytic type probably psychogenic in origin A tube was passed and left in place until intestinal activity returned When he was once more able to eat normally, the tube was withdrawn and he continued in good health, free from digestive complaint (Fig 1).

METHOD

The procedure is based on the method described by Miller and Abbott for intubation of the small intestine. For the relief of intestinal obstruction it is best carried out as follows. The patient is lifted to a litter and brought to a fluoroscopic room. The litter mattress with the patient on it is slid upon the fluoroscopic table. A No. 14 or No. 16 F duodenal tube with a No. 3 F rubber tube lightly tied to it is passed in through the patient's nose and out at his mouth. On the end of the larger tube is tied a duodenal bucket and on the end of the fine tube stiffened by a centimeter length of small brass tubing is tied a thin rubber balloon which, when inflated, holds 50 cubic centimeters of air. The collapsed balloon is tied beside the tip of the larger tube and then the distal end of the apparatus is drawn back into the patient's pharynx and swallowed. When the duodenal bucket can be seen by the fluoroscope to have reached the mid duodenum a volume of about 30 cubic centimeters of air is injected into the balloon while constant suction is maintained on the larger tube. As the gas and fluid are sucked out of the gut the intestinal walls contract and, regaining their normal propulsive movement, they force the balloon ahead. The suction likewise collapses the intestine loop by loop, as the tip of the tube advances until the obstruction is reached, by which time relief of distention and with it relief of pain have occurred. In some instances no other treatment is necessary.

Variations in the apparatus are occasionally desirable. Our standard two lumen tube¹ has been used at times but has proved too large and stiff to be passed with ease through the nose of an average patient. The ideal tube should have two lumina, one very large for the aspiration of intestinal contents and one very small for the introduction of air into the balloon. Such a tube has just been devised for us and is proving satisfactory.*

Variations in the method of passing the tube have been used. In many individuals the nose will permit the passage of the tube with the balloon and a Swiss duodenal tip already

attached. When fluoroscopic control seems inadvisable, as is often the case, the tube may be started according to the usual routine for passing any duodenal tube, the balloon being inflated when characteristic duodenal contents begin to flow. If for any reason the patient can not be rolled on his right side to let the bucket "sink" to the pylorus, he may be rolled on his left side and sufficient air placed in the balloon to "float" it to the pylorus. When this is attempted the stomach must first be emptied as air in the stomach will prevent the balloon from "floating," otherwise suction should be deferred until the tube has entered the duodenum as the pylorus is often dilated together with the stomach and so may be more easily traversed before than after deflation has been accomplished.

In the cases in which an organic obstruction is suspected, diagnostic measures may now be undertaken. The injection of a small amount of barium sulphate in dilute suspension will frequently indicate the point of constriction and the pattern of the intestinal mucosa. The examination of the aspirated contents for blood further aids in distinguishing intrinsic lesions involving the mucosa from extrinsic lesions such as adhesions which have obstructed the lumen by pressure from without. Manometric determinations of the pressure exerted by the intestinal wall upon the balloon give further indication of the element of spasm involved.

Having deflated the gut and if possible identified the obstruction by barium injection and study of the intestinal contents, one may leave the apparatus in place for days with constant or intermittent suction. If function has been restored the tube may still be left in place without suction being applied to meet further emergencies should they arise. Otherwise the balloon should be deflated and with gentle traction the tube may be pulled backward through the small gut and stomach, even though the tip had reached the ileocecal valve. The longest time required for the withdrawal of 10 feet of tubing in our experience has been 15 minutes; ordinarily 10 minutes suffice.

In a normal individual the apparatus will advance along the intestine at the rate of about 1 centimeter per minute or 2 feet an



Fig 1 Paralytic ileus Case 3, F F a, left Small intestinal distention 4 days after operation b, Decompression of the intestinal tract by the passage of a No 14 F tube for aspiration fastened to a No 3 F tube bearing an air-filled balloon

hour. A length of 6 to 8 feet of tubing is generally enough to reach from the pylorus to the cecum (8 to 10 feet beyond the teeth) In obstructed cases a rate of about 1 centimeter in 2 minutes (1 foot in an hour) is nearer the average It is important that the tubes be marked at 6 inch intervals so that the patient or the nurse may be given a schedule to insure correct speed of swallowing, as a coil in the stomach from too rapid passage will sometimes check its advance

RESULTS

Intubation for the relief of intestinal obstruction has been attempted on 16 individuals with failure in only 3 While the symptoms in one or two instances were mild, the patients as a rule, were desperately ill In 9 instances function returned spontaneously following a variable period of decompression Paralytic ileus and organic obstructions have responded in an essentially similar fashion (Figs 1, 2, and 3) In the 4 cases in which the obstructing lesion was studied roentgenologically after the injection of a barium sulphate suspension through the tube, the point of closure was identified and the end of the tube was found to be lying within a finger's length of the obstruction itself (Fig 4)

As the severity of intestinal obstruction can vary so widely, depending on the attendant circumstances, a brief sketch of each case

follows. The data bearing upon the technique employed are presented separately in a summary table.

CASE REPORTS

Patients who became obstructed while under observation

CASE 1. J K, male, 73 years of age, with symptoms of chronic prostatism, became slowly obstructed by a carcinoma of the cecum Intubation was carried out while he was in a state of shock from pain, distention, and vomiting He was so relieved that he pulled the tube out later that night At that time the abdomen was flat, peristalsis was normal and his general condition was good Subsequently, however, distention recurred and operation without intubation was attempted, but he died

CASE 2 W S, male, 42 years of age, suffered a spontaneous rupture of a duodenal ulcer, was operated upon, and convalesced normally for 7 days Fever and great abdominal distention, accompanied by streptococcic septicemia, then developed rapidly with a disappearance of peristalsis The obstruction was of a paralytic type associated with infection. Intubation carried him over the period of ileus and ultimately, when he was able to eat, the tube was withdrawn without a recurrence of the symptoms

CASE 3 F F, male, aged 68 years had undergone an exploratory laparotomy because of sudden weight loss and constipation His abdominal cavity was practically normal but the patient was in an agony of fear, believing that he was dying of cancer His obstruction was of a paralytic type probably psychogenic in origin A tube was passed and left in place until intestinal activity returned. When he was once more able to eat normally, the tube was withdrawn and he continued in good health, free from digestive complaint (Fig 1).



Fig 2

Fig 2 Inflammatory intestinal obstruction. Case 4. K. A. a left. Widely dilated small intestinal loops filled the abdomen. b Decompression of the abdomen after intubation. At the time this film was taken the patient had swallowed the tube too rapidly with resultant coiling in the stomach.

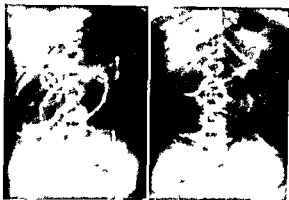


Fig 3

Fig 3 Mechanical intestinal obstruction. Case 9. V. B. a left. Marked small intestinal distention was present before intubation. b Decompression of the abdomen following the passage of a No. 14 F. and a No. 3 F. tube.

CASE 4. K. A. male aged 40 years underwent a resection of gangrenous ileum which was found strangulated in a ventral hernia. Convalescence was interrupted by the occurrence of intestinal obstruction which came on with the development and drainage of a pelvic abscess and was probably based on inflammatory swelling of the intestinal wall. Following sustained decompression of the lower ileum he made an uneventful recovery (Fig. 2).

CASE 5. D. P. a young adult male suffered slowly increasing intestinal obstruction from the sixth to the tenth day after an emergency operation for a gunshot wound of the abdomen which had punctured his stomach. The obstruction which was long continued was probably at the start on an inflammatory basis with the mechanical factor of adhesions developing later. The point of obstruction was identified by the fluoroscopic observation of an opaque mixture injected through the tube. He was later operated on the adhesions were released and a satisfactory recovery followed.

CASE 6. J. M. male aged 15 years began to develop symptoms of intestinal obstruction 16 days after the surgical repair of a gunshot wound of the small intestines. The obstruction in this case was on

an inflammatory basis. After adequate decompression of his lower small intestine operation was rendered unnecessary by the patient's recovery.

CASE 7. G. L. a man of 62 years became progressively distended with paralytic ileus during a 9 day period following the performance of a suprapubic cystostomy for the removal of a vesical calculus. Intubation was easily accomplished with relief of his symptoms and restitution of normal intestine activity. He remained free from digestive symptoms thereafter.

Patients admitted to the hospital because of existing intestinal obstruction

CASE 8. R. J. female of 27 years had suffered three hospitalizations for intestinal obstruction following a cesarean section 4 years before. During one of these admissions she was operated on for lysis of adhesions. She was finally admitted after 4 days of vomiting with symptom probably due to edema developing in the intestinal wall at a point of partial obstruction present since her former operation. The location of the obstruction was identified by fluoroscopy of an injected opaque medium. This attack was completely relieved by intestinal intubation.



Fig 4 The localization of a mechanical obstruction. Case 12 W S a, Small intestinal distention was marked prior to intubation. The colon is outlined by the unexpelled residue of a barium enema. b The small intestine has been decompressed by the passage of a No. 14 F and a No. 3 F tube. Barium has been injected down the tube and has regurgitated up a dilated loop of ileum. Its ad-

vance is blocked by a point of narrowing (arrow) just distal to the air-filled balloon and the tip of the tube. c, After film b was taken vigorous massage was successful in forcing barium through the constricted area of intestine (arrow) beyond which the opaque medium passed in a normal manner. Operation revealed a band of omentum binding this loop of ileum to the promontory of the sacrum.

Operation is contemplated as soon as she recovers from an acute pelvic inflammatory disease.

CASE 9 V B, a young negress, had suffered since the delivery of her child 2 months before from attacks of abdominal colic and vomiting, coming on with increasing frequency. Complete intestinal obstruction had occurred 48 hours prior to admission and was probably on a mechanical basis secondary to antecedent inflammation. The point of obstruction was located by the fluoroscopic observation of a suspension of barium sulphate injected through an intestinal tube and was found to be within 4 inches of the ileocecal valve. Normal intestinal activity eventually returned and she was discharged free from symptoms (Fig 3).

CASE 10 W P, negro, male, 68 years of age, was admitted after 3 days of abdominal colic with vomiting and failure to pass gas or feces by rectum. Intestinal intubation relieved his symptoms. The obstruction was of mechanical origin due to a malignancy at the ileocecal valve. This lesion was likewise identified by the injection of a barium sulphate suspension. An ileocolostomy was performed and he has refused to have the mass resected.

CASE 11 J F, male, 31 years of age, was admitted with intestinal obstruction beginning 2 months after the drainage of an appendiceal abscess. Intubation brought complete relief. Subsequently an appendectomy was performed with normal convalescence. At operation a portion of the terminal ileum was found adherent to the abdominal wall. This was not released because of technical difficulties. He was admitted again with intestinal obstruction, swallowed the tube himself, and was relieved. This succession of relief, withdrawal of the tube and recurrence of symptoms occurred repeatedly for a month after

which his digestive tract continued to function fairly normally. Obstruction in this instance was probably due to an underlying mechanical factor with superimposed local inflammation.

Patients with partial intestinal obstruction intubated primarily to locate the lesion after the failure of other diagnostic procedures

CASE 12 W S, the patient previously described as Case 2 was treated for septicemia by transfusion of sulphanilamide, the drainage of metastatic abscesses and supportive treatment until by the seventh week his temperature was normal and convalescence was established. Flatulence then returned, succeeded by slowly increasing distention, nausea, and colic. Roentgenoscopy showed gas filled small intestinal loops. The colon appeared normal when studied by barium enema. Constant suction drainage of the duodenum failed to relieve his symptoms. A tube was passed as far along the ileum as it would go, with prompt relief. A barium suspension was then injected locally and a point of partial obstruction was located. The abdomen was opened, a band of inflamed omentum was found constricting the ileum at the point indicated and with the release of this an uneventful recovery followed. (IV)

CASE 13 R O, female, aged 40 years, had suffered for 14 years from recurrent periumbilical pain with nausea and flatulence. Repeated gastro-intestinal roentgenological studies had failed to identify a diseased point but indicated abnormal small intestinal function. A tube was passed to the middle ileum beyond which point it would not go. A barium sulphate suspension injected through the tube demonstrated an acute angulation which next day was found on surgical exploration, to have been pro-



Fig 2

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decompressed has not previously been described. That such is the case and that it offers a valuable therapeutic method for the relief of such cases as are here reported is clear. We feel that the additional handling of a shocked patient, necessitated by the procedure, is justified by the benefit derived and that the delay caused in patients ultimately requiring surgery is not great enough to be of serious consequence. This delay can be lessened, moreover, by the use of the long tube from the start in a patient requiring decompression rather than by passing a duodenal tube first and attempting deflation of the jejunum and ileum only if the shorter instrument is inadequate. The tip of any tube is usually found to have entered the duodenum before it has been many hours in the stomach, so that if one has started with the long tube and the patient's response is not satisfactory he then need but inflate the balloon and allow the apparatus to advance as far as it will. The value of the procedure must depend on the judgment of the individual physician. When gangrene of the intestinal wall or a clear localization of obstruction, as in an external hernia, is present, small intestinal intubation constitutes a definite added hazard, but, excluding these cases, there still remain many for which small intestinal intubation should be tried before surgery, as a means of improving the patient's condition, of decreasing the technical difficulties of the operation, and not infrequently of rendering the operation unnecessary.

CONCLUSION

A double lumen tube or a pair of tubes may be passed rapidly down either a normal or an obstructed small intestine by inflating within the duodenum a rubber balloon on the end of the tube to a degree sufficient to stimulate propulsive peristalsis. This intestinal response

takes place whether the obstruction is due to infection, mechanical occlusion, or paralytic ileus. Gas and fluid may be aspirated from the entire length of the small gut by the application of constant suction as the tube advances. Prompt and striking symptomatic relief occurs as the decompression of the intestine is accomplished.

By the injection of very small amounts of barium sulphate suspension down such a tube, by microscopic study of the intestinal contents aspirated, and by the character of the intestinal contractions, the location and often the nature of the obstructing lesion may be determined.

The advance of the tube has been found to proceed until the tip has reached the obstructed region.

In not a few instances decompression alone has released the obstruction, rendering operation unnecessary.

We wish to thank Dr. Eldridge L. Eliason and Dr. I. S. Ravdin for the privilege of reporting cases from their services and Dr. E. P. Pendergrass and his associates and Dr. C. Kenning and his associates for assistance with roentgenological phases of this work.

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SUMMARY OF 16 CASES OF INTENSIVE OBSTRUCTION TRIED BY SMALL INTESTINAL INTUBATION

Subjects	Diagnosis	Duration of symptoms	Dehydrated	Diet	Clinical	Life	Intubation	Time tube remained in place	Time until evacuation	Barium sulfate present in stool	Point of obstruction found	Type of relief necessary	Result
1. J. K.	Small intestine	2 d 15	Yes	+++	+++	+++	Yes	0 h	0 h	No	No	Yes	Yes
2. J. S.	Small intestine	2 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
3. J. L.	Small intestine	7 d 15	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
4. J. M.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
5. J. N.	Small intestine	8 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
6. J. O.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
7. J. P.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
8. J. Q.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
9. J. R.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
10. J. T.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
11. J. U.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
12. J. V.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
13. J. W.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
14. J. X.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
15. J. Y.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No
16. J. Z.	Small intestine	4 d 30	No	+++	+++	+++	Yes	0 d 30	0 d 30	No	No	No	No

duced by a ring of adhesions doubling back the ileum upon itself. Recovery was uneventful.

Failures

CASE 14. A D. female 75 years of age, was intubated 1 hour after operation for a strangulated femoral hernia. The procedure was attempted because inversion of a small gangrenous area of the intestinal wall had been necessary and ileus was expected. The tube could not be made to leave the stomach.

CASE 15. W B. a laborer 50 years of age was intubated for progressive intestinal obstruction coming on insidiously weeks after an operation for the relief of a subdiaphragmatic abscess. He had suffered a spontaneous rupture of a duodenal ulcer a year and a half before had developed a duodenobronchial fistula and at the time intubation was attempted was in extremis with ascites and an open external fistula. The tube could not be made to leave the stomach. Death ensued 48 hours later.

CASE 16. L V. aged 81 years was admitted with intestinal obstruction. A large diaphragmatic hernia was found and intubation was attempted. The tube could not be passed beyond the stomach. Death ensued and at necropsy it was found that the diaphragmatic hernia was inconsequential, the obstruction being caused by a Richter's hernia of the femoral canal.

It has been shown by Scheltema and by Einhorn that a tube left in the digestive tract will ultimately appear at the anus. Jones and Pierce have used a balloon on a tube and observed its passage throughout the gut and the studies of Miller and Abbott have led to methods for rapidly reaching and emptying part of the small intestine. On the basis of their experience similar intubations have been accomplished in patients with varying types of obstruction of the intestine. From the diagnostic point of view, a study of the material aspirated is of importance. Chemical analysis is revealing the degree to which the electrolyte balance of the intestinal contents is disturbed and a microscopic examination of the sediment for blood or cells contributing evidence as to the nature of the obstructing lesion. A manometer or recording instrument connected with the balloon likewise is useful in estimating the motor responses of the intestine above the obstruction. The rapidity with which a distended and silent jejunum or ileum or one vigorously manifesting reverse flow will revert to normal motor function when

terminal arterioles and capillaries into the venous system that determines the amount of blood pumped by the heart. This rate, on the other hand, is determined by the amount of blood required to keep the diffusion pressures in them of oxygen and carbonic acid approximately constant. Y. Henderson has further developed this idea in his "venopressor reflex." Consequently the regulation of both circulation and breathing is essentially chemical and is governed by the same factors.

Thus it becomes obvious that any cause which interferes with the maintenance of normal partial gas pressures in the tissues may start asphyxia. Reduction of oxygen supply, —caused by obstruction of the air-ways or by decreased permeability to gases of the respiratory pulmonary membrane (inflammatory edema, destructive lesions) or by reduction of the respiratory field (retention of exudates, bronchial obstruction, atelectasis, pneumothorax, empyema), or by reduction of oxygen in the inspired air, has its immediate repercussion upon the function of the respiratory center. Anoxemia of the respiratory center causes increase of the respiratory rate which may or may not correct anoxemia. If it does not, a vicious cycle starts which, if not broken, leads to fatigue of the respiratory center and death. This cycle begins with tachypnea which washes out carbon dioxide and leads to apnea. Because of the elimination of the normal stimulus of the respiratory center there is a further increase in anoxemia; furthermore, because of the decreased partial tension of carbon dioxide, hemoglobin is saturated to a higher degree with the available oxygen (Bohr phenomenon). Thus cyanosis may be absent although anoxemia is increased because of the production of a more stable oxyhemoglobin compound under decreased carbon dioxide tension. On the other hand, the drop in partial pressure of carbon dioxide in the tissues decreases the muscular tonus necessary for the propulsion of the blood from the terminal arterioles and capillaries into the veins and the right heart (venopressor reflex of Y. Henderson). This author, to whom we owe so many important contributions on this subject, believes that the decrease of carbon dioxide abolishes mus-

cular tonus. This is possible. However, as we do not know exactly what muscular tonus is, the actual existence of this reflex is subject to discussion. Keith called the terminal arterioles "peripheral hearts" meaning, as does Henderson, their importance in the propulsion of the blood. Whatever the mechanism may be, it is certain that a considerable decrease of carbon dioxide causes a drop of arterial pressure and peripheral stasis which further increases anoxemia.

Moreover, just as respiratory disturbances are caused by anoxemia so does impaired cardiac action due to organic diseases of the heart lead to anoxemia by defective circulation, blood stasis, and finally pulmonary edema. Thus, asphyxial death in cardiac disease is caused by the same mechanism as asphyxial death in pulmonary diseases or in obstruction of the air-ways.

These considerations were necessary, I believe, because, among many internists and surgeons, there is still a tendency, regarding the mechanism of asphyxia, to separate circulation from respiration and to disregard this close correlation and interdependence existing between them. Asphyxia can be defined as "the disturbance of gas exchanges in the tissues caused by abnormal breathing, or abnormal circulation, or of defective oxydative ability of the tissues"; therefore, it should be treated as a whole, with the main objective of re-establishing the normalcy of gas exchanges in the tissues.

It should always be borne in mind that progression of asphyxia due to defective oxygen supply may proceed with extreme rapidity. In fact, we possess no other reserve of oxygen in our organism than 600 cubic centimeters which is present in the 4,000 cubic centimeters of air contained in our lungs (which contains 15 per cent of oxygen). This amount is hardly sufficient for maintaining life for 2½ minutes when all supply from the outside is cut off. In fact, seven or eight breaths of a neutral gas, such as nitrogen, or hydrogen, bring loss of consciousness due to oxygen want and are followed by death if oxygen is not replenished.

The scope of this study does not allow a more detailed discussion of the chemical and

MECHANICAL RESUSCITATION IN ADVANCED FORMS OF ASPHYXIA

A Clinical and Experimental Study in the Different Methods of Resuscitation

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DEATH of the body as a whole in higher organisms, said Paul Bert (1878), is always due to want of oxygen, whatever its cause may be. Life is continued so long as exchanges of oxygen and carbon dioxide in the tissues are carried on in a normal way. Gas exchanges depend upon and are regulated by their respective partial pressures and the aim of pulmonary ventilation is precisely to maintain these pressures at constant levels whatever

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may be the metabolic needs of the different tissues

On the other hand, the supply of oxygen and the removal of carbon dioxide are accomplished by the circulating blood. Therefore circulation is but a part of respiration and both co-operate in the closest way in order to maintain and preserve constant the conditions of life in the internal environment of the blood, as Claude Bernard said in his 'Lessons on the Phenomena of Life'

Thus we arrive at the fundamental conception of the physiology of respiration—that respiration and circulation are so regulated as to keep both oxygen pressure and oxygen ion concentration very nearly constant in each part of the body, and that respiration and circulation are regulated by the changes in gas pressures in the tissues during life. When once, says Haldane, the fundamental fact is grasped that the flow of blood through the body is correlated with gas pressures in the capillaries, the whole physiology of circulation appears in a new light. It is neither the heart nor the nervous centers which govern the circulation rate but the tensions of gas in the tissues as a whole and they govern it with an accuracy and delicacy comparable to that with which they govern breathing. The heart and vasomotor system are only the executive agents which carry out the bidding of the tissues just as the lungs and nervous system do in the case of breathing.

Thus the problem of the regulation of circulation under normal conditions seems in the main to resolve itself into that of the regulation by the tissues of the amount of blood supplied to the heart (Haldane). In other words it is the rate at which the systemic blood is allowed through the tissues from the



Fig. 1. Lung of dog. 2. Use of the apparatus during 4 hours. Slight marginal consolidation of the left lower and partial consolidation of the left upper and right leaf of the accessory lobes.

lower jaw relaxes because of gradual suppression of muscular tonus. Spurious inspiratory movements of lips and nostrils replace real respiratory ones and no effective respiratory movements can be detected. The skin is clammy and covered with cold sweat. The radial and femoral pulses are no longer perceptible. Patella reflexes disappear and the sphincters relax. Heart beats are uncertain and it is impossible to say at this phase whether the patient is still alive or that death has occurred.

These are the three principle forms of asphyxia with which we are usually faced. All intermediate forms may be encountered and the passage from one to the other may occur with disconcerting speed.

Time is of paramount importance in the management of asphyxia. One should never forget that it is easy to cope with slight asphyxia whereas it is very difficult, if not impossible, to resuscitate a man or animal after the heart has ceased to beat. Therefore, at the slightest threat of asphyxia, measures for resuscitation should start at once without waiting for possible spontaneous resumption of respiration.

The considerations mentioned give the key to the alarming rapidity with which asphyxial death may occur in patients with pulmonary diseases. In fact these patients are strongly handicapped to any increase of their anoxemia because of their chronic anoxemia due to the pulmonary disease. This factor is of paramount importance in the complete understanding of asphyxial accidents in these patients and of the requirements for successful resuscitation. Therefore, chronic anoxemia deserves special consideration.

Chronic anoxemia In cases with chronic pulmonary suppuration, such as tuberculosis, abscess of the lung, bronchiectasis, extensive silicosis or malignancies and more so in acute pulmonary diseases especially in bronchopneumonia, anoxemia is always present because of uneven pulmonary ventilation, inflammatory edema of the respiratory membrane, partial destruction of the pulmonary parenchyma or atelectatic and fibrotic dismemberment of a portion of the lung. As a rule compensatory polycythemia is present in

these cases. The slightest increase of anoxemia in these patients may be the cause of asphyxia and rapid death, apparently disproportionate to the cause which has produced it. Thus in advanced pulmonary tuberculosis even moderate pulmonary hemorrhage, or passage into the bronchial tree of a few cubic centimeters of pus from an empyema cavity, or obstruction of a bronchus of the healthy lung with bronchial exudate coming from the diseased side, or spontaneous pneumothorax of the diseased or of the contralateral side, may cause rapidly lethal asphyxia. For example, a patient who during bedrest is only slightly dyspneic, and who, disobeying orders, gets out of bed to go to the lavatory, may drop dead because of this otherwise slight exertion.

The knowledge of this chronic anoxemia, to which the organism may be temporarily adjusted by decreased oxygenation rate in the tissues and possibly by active oxygen secretion of the alveolar epithelium (Ludwig, Haldane), is of the greatest importance to the internist and the thoracic surgeon. Haldane wrote in his classic *Treatise on Respiration*: "If there were only one clinical lesson derived from the perusal of this book I hope that it would be that chronic anoxemia is a very serious condition the continuance of which ought to be prevented if at all possible."

These considerations make it easy to understand the dangers to which these patients are exposed when they are operated upon. It is my contention that the prohibitive mortality at the beginning of thoracic surgery, more especially in tuberculosis of the lung and other chronic suppurations of this organ, was due to the imperfect knowledge of chronic oxygen want. Respiratory failures, acute dilation of the right heart, and cardiac decompensation were the usual diagnoses on the death certificates. We know today that all these vague terms must be replaced by "anoxemia." If actually, without any radical changes in operative technique, we are able to operate upon patients with even far advanced and bilateral pulmonary tuberculosis or bronchiectasis with a remarkable degree of safety, it is because of better knowledge of chronic anoxemia, of improved administration

nervous regulation of respiration which I have presented elsewhere in their relation to the tuberculous lung (5, 6) I shall mention here only two more points. First is the so called Herring Breuer reflex in which expansion of the alveoli causes arrest of inspiration and starts expiration, and collapse of the alveoli causes arrest of expiration and starts inspiration. The legs of these reflexes are represented by afferent and efferent fibers included in the vagus acting upon the respiratory center. Conversely, through this reflex, distention and collapse of the lung in the mechanical treatment of asphyxia may act as powerful stimuli upon the respiratory center. The second point to be mentioned is the significance of rhythmic respiratory variations of intrapulmonary and intrapleural pressures upon the function of the heart. It is obvious that marked increase of the intrapulmonary and, consequently, of the intrapleural pressures hinder the suction of blood into the large veins and interfere with their emptying into the right heart. In these cases venous blood pressures rise and the amount of blood passing into the right heart, the lungs, and back into the left heart, may be considerably decreased. However, as will be shown later, this phenomenon is of no great importance so long as intrapulmonary hyperpressures are not very high or of long duration, this is due to the marked differences of blood pressures in the large arteries and the large veins.

ASPHYXIA

Causes. The causes producing asphyxia may be divided into seven major groups (Meakins and Davies)

1. Insufficient partial pressure of oxygen in the inspired air (high altitudes)
2. Obstruction of air passages or resistance to respiration
3. Obstruction to the passage of gases from the alveoli to the blood (edema, inflammation, exudation, destructive lesions emphysema)
4. Alteration of oxygen carrying capacity of the blood (anemia, carbon monoxide nitrate or chlorate poisoning)
5. Circulatory failure
6. Pollution of the oxygenated blood by its

mixing with the venous blood (Uneven ventilation of the lungs unaerated channels, congenital cardiopathies and the like)

7. Inhibition of oxydative processes in the tissues (cyanide poisoning)

Of all forms of asphyxia the most important for the internist and the thoracic surgeon are the ones due to obstruction and resistance to respiration, to inflammatory edema of the alveolar membrane to the creation of unaerated channels with pollution of the oxygenated blood and to the toxic action upon the respiratory center of anesthetic gases.

Forms of asphyxia. Asphyxia should be divided, according to its degree into three forms

1. *Slight asphyxia.* This form is characterized by persistence of respiration and circulation, dyspnea is present and is accompanied by a variable degree of cyanosis. The degree of cyanosis, however, is not always proportionate to the degree of asphyxia. Slight resistance to respiration by partial tracheal obstruction may cause considerable cyanosis with gasping for air, because of retention of carbon dioxide although the grade of anoxemia may be slight. On the contrary in the presence of extensive involvement of the bronchial and alveolar mucosa cyanosis may be slight or absent (gray cyanosis) while periodic or shallow rapid breathing indicate marked anoxemia. Gray cyanosis follows considerable washing out of carbon dioxide (Bohr phenomenon), and shows an advanced degree of anoxemia.

2. *Moderate asphyxia.* If not corrected in time, slight asphyxia progresses rapidly to a more advanced stage. The rate of respiration becomes greatly increased, periodic and shallow breathing develops, leading to fatigue of the respiratory center. Arterial blood pressure falls after a temporary elevation. Venous pressure rises and convulsions may appear at this phase.

3. *Severe asphyxia.* These forms are characterized by apnea, extreme drop of arterial pressures and failing or arrest of the heart. After convulsive attacks the body gradually relaxes and becomes flaccid. Consciousness is gone, the eyes are glassy, corneal reflexes disappear, and pupils begin to dilate. The

there was loss of muscular tonus with dropped jaw, dilated pupils and abolished glottis reflex

This method, however, presents two serious drawbacks. One, common to all resuscitation procedures, is that the air-ways are not always patent. In the operating room or in the postoperative wards this is easily insured by the introduction of an intratracheal catheter. In the field this can be also easily accomplished with Flagg's suction bottle and the introduction of a pharyngeal air-way or of a Magill catheter. The second drawback, specific to this procedure, is the exposure of the operator to contamination by tuberculous patients, and the impossibility, because of the fetor, of carrying the insufflation for any length of time in cases with anaerobic suppuration of the lung.

It was precisely the necessity of replacing the surgeon or the anesthetist by some mechanical device accomplishing the same or similar work that has induced me to investigate the different apparatus on the market based on the pulmotor principle. Thus I was led to the experimental and clinical study of the apparatus known as the E & J resuscitator.

Mechanical resuscitation. The E & J apparatus consists of two parts. One acts as a simple inhalator. The other as resuscitator. The latter is a mechanical device composed of a number of valves which are activated by the pressure of the usual oxygen or carbon dioxide in oxygen mixture delivered in tanks under a pressure of 2,000 pounds. When a positive pressure of 14 millimeters of mercury is built up in the mask of this apparatus the valves are automatically reversed and a suction of -9 millimeters of mercury is produced which is again followed by a positive pressure of 14 millimeters of mercury, and so on. In other words, it is a machine based on the principle of the automatic type of the Draeger pulmotor, in which the pressures are constant whereas the volumes of gas vary with the capacity of the lung of the patient.

Such an apparatus, however, was subject to a number of serious criticisms which required thorough experimental study before any clinical trial could be attempted. The principal objection is that intrapulmonary

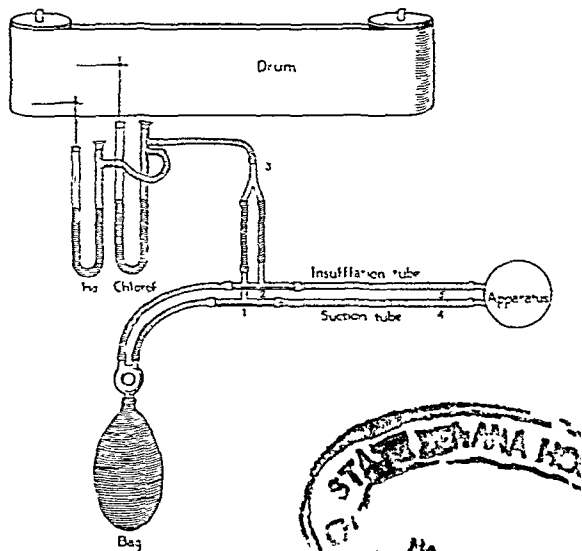


Fig 2 Testing the E and J resuscitator. The two tubes coming from the apparatus, 4 and 5, are connected with two T tubes, 1 and 2. The vertical branches of these tubes are connected with a Y tube, 3, which is connected with two registering manometers, mercury and chloroform. On the other hand the two tubes, 4 and 5, are connected with a rubber bag representing the lung.

and intrapleural pressures produced by this apparatus during inspiration and expiration, are positive during inspiration and negative during expiration, that is the opposite to those in normal respiration. Therefore, a list of requirements was drawn which was submitted to strict experimental investigation. These requirements are the following:

1. Is this apparatus technically reliable and constant in its action? Is it constant in both positive and negative pressures independently of pressure in gas tank, does it function regularly under prolonged action?

2. Is its prolonged use without any danger, either organic upon the lung or functional upon respiration and circulation?

3. What is the efficacy of this apparatus in cases of asphyxia; mechanical (submersion, laryngeal, or tracheal obstruction) or chemical (anesthetic gases)?

4. Can this apparatus be used, experimentally, in long operations upon intrathoracic organs (heart, lung, and esophagus) in which the pleural cavity is maintained open for a long period (over 3 hours)?

of anesthesia, and of more rational pre operative preparation and postoperative management of these patients. This has been accomplished by a closer correlation between operating work and the research laboratory. Chest operations are conducted today with the accuracy and minute precautions of physiological experiments, conversely laboratory animals are subjected to similar operations after previous preparation rendering their condition as similar as possible to our patients (5).

The result of this close co-operation of operating room and laboratory during the last 5 years in the two departments of thoracic surgery under my direction, in the Metropolitan and Sea View Hospitals of the City of New York, has been that the mortality has fallen from 20 per cent of 5 years ago to below 8 per cent even though patients with far more advanced conditions are being submitted to surgical treatment, especially during the last 3 years.

The ideas on asphyxia and resuscitation expressed in this study have been developed during this work. They may, occasionally, be in disagreement with generally accepted opinions, nevertheless they are backed, I believe, by substantial clinical and experimental evidence.

MANAGEMENT OF ASPHYXIA

Little will be said regarding the first two forms of asphyxia. Careful removal of any foreign material obstructing the bronchi followed by manual rhythmic compression of the chest and inhalation with 7 to 10 per cent carbon dioxide in oxygen is generally sufficient to restore regular respiration. However prolonged administration of carbon dioxide in oxygen (5 to 7 per cent) may be required after resuscitation until the danger is over. This is especially important in carbon monoxide poisoning in which protracted oxygen carbon dioxide inhalation treatment is of paramount importance for complete recovery and prevention of complications.

More important and far more difficult is the management of the severe forms of asphyxia. I want to insist upon the point that in cases with apnea no time should be

lost with attempts of resuscitation by inhalation and manual artificial respiration. This applies not only in chest surgery where manual resuscitation is out of the question but also in all cases of asphyxia in which the patient does not breathe. It is obvious that in such cases oxygen has to be forcibly introduced into his lungs. Even beginning flaccidity causes the chest to collapse in position of extreme expiration, so that little air, if any, can be aspirated into the lung by the expansion of the chest following the compression by the methods of Shaeffer or Sylvester or any other. I agree perfectly with Yandel Henderson that "the inspirations that occur between compressions (in manual artificial respiration) are produced wholly by the tonic elasticity of the victims' mid expansion. After the body is flaccid no form of manipulation can induce the slightest inspiration."

Mouth to mouth insufflation. The mode of resuscitation that has given me the best results in cases of severe asphyxia, is the immediate application of mouth to mouth insufflation. I know of no method of resuscitation more efficient and more rapidly effective. In a number of instances with patients apparently dead, this method has produced striking resuscitations. It is a puzzle to me that this mode of resuscitation is not mentioned in the treatise of Haldane or in the writings of Yandel Henderson on resuscitation. Waters and Bennet, on the contrary in a recent paper in which they had studied the respective merits of different methods of manual resuscitation concede that the best of them (Sylvester's) is second only to mouth to mouth insufflation. Physiologically this is a sound procedure because it allows the immediate administration of the correct mixture of carbon dioxide in oxygen under the correct conditions of temperature, moisture, pressure and at the proper intervals. Moreover it takes advantage of the powerful Hering Breuer reflex.

Such striking results have been obtained by this procedure that it has been routinely used in my services during the last 10 years in all patients with asphyxia. Patients have been revived in whom the heart beats could hardly be detected and only by the movements of intracardiac needle, and in whom

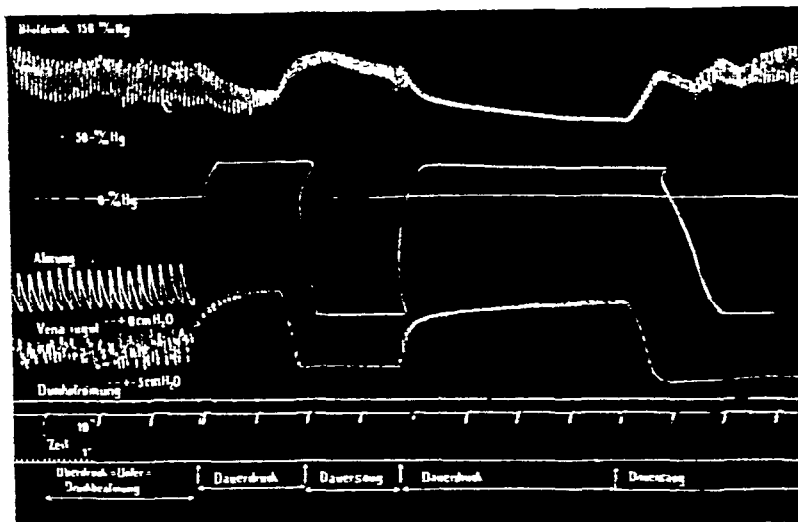


Fig 5 Action of intrapulmonary hyperpressure (20 cm. of water) and hypopressure (-20 cm of water) upon arterial and venous pressures. From up down, arterial pressure, intrapulmonary pressure, venous pressure and time in seconds. As the intrapulmonary pressure rises the arterial pressure drops and venous pressure rises (graph of Rost)

rapidly to 14 millimeters of mercury, 3, and falls almost vertically to minus 9 millimeters of mercury, 4, from which it rises to a slightly negative pressure, 5. If we neglect the intermediate oscillations due to the play of the valves and the "jumps" of the manometer (Fig. 3B) we can distinguish in the action of the apparatus two phases. (1) $1'$, $2'$, $3'$ of insufflation and a second, $3'$, $4'$, $5'$, of suction. Before the rise as before the fall, we find a period of slightly positive, $1-2$ and another of slightly negative, $0-1'$ pressures which constitute two-thirds of the cycle.

As the tempo of the cycle depends upon and is regulated by the pressure obtained, it becomes more rapid when the capacity of the lung (the bag here) is decreased and slower when the capacity is increased. Likewise it is influenced by the "volume" of gas allowed to enter the apparatus. Thus, obstruction of the air passages is immediately signaled by the rapid tempo of the apparatus.

On the contrary, the changes occurring in the pressure in the gas tank as it empties were shown to be without any marked influence upon the pressures and rhythm of the respiratory cycle. Tracings were taken with pressures in the tank decreasing from 1800 to

30 pounds. Figure 4 shows that there were no appreciable changes either in the height or in the frequency of the oscillation when the pressure of the tank has fallen to only 30 pounds.

The apparatus was tried in continuous function for 12 hours without showing any changes in the tracings.

It was concluded, therefore, that the mechanical construction of this apparatus insures a regular, accurate, and prolonged function which is maintained unchanged until the tank is practically empty (30 pounds' pressure).

Effects of prolonged action of the apparatus upon normal dogs (without previous operation). The problem to solve was whether prolonged use of the apparatus on normal dogs caused any organic lesion of the lung or any functional disturbances of respiration and circulation, and for how long the use of this apparatus could be prolonged without any untoward effects.

Before giving our experimental findings I think it is of interest to quote from the literature on the effects on intrapulmonary hyperpressures and hypopressures.

Chillingworth and Hopkins (1930) carried

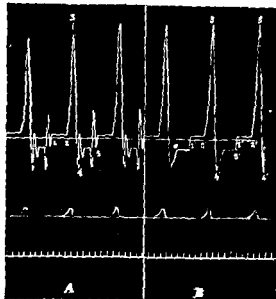


Fig 3 Graphs taken with the outlay shown in Figure 2 A shows above the actual graphs of the chloroform manometer and below of the mercury manometer. Times are registered in seconds. 1, 2 and 3 show the building up of positive pressure (14 mm Hg) 4 and 5 the negative pressure. B shows the same graph when the parts of the curve representing opening and closing of the valves had been eliminated in order to show more clearly the function of the apparatus.

5 What are the results if any obtained from asphyxiated and apneic animals, the lungs of which have been maintained ventilated by this apparatus, when direct massage of the heart is applied several minutes after complete arrest of cardiac action?

6 What is the action of this apparatus on humans who have developed apnea in the course of, or following thoracic operations?

EXPERIMENTAL INVESTIGATION

It is obvious that the points raised above could not be answered satisfactorily by superficial inquiry or with preconceived ideas for or against the principle upon which this apparatus is based. Therefore these problems were submitted to a long experimental investigation which was carried out in the laboratory of Surgical Research of Cornell Medical College, with the collaboration of Dr G L Birnbaum. Forty-two dogs were used. A number of clinical observations and experi-

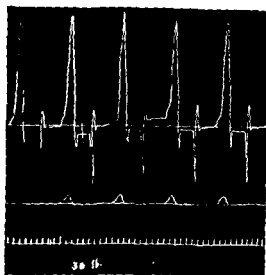


Fig 4 Tracing taken while the tank was almost empty and pressure in it was of 30 pounds only (initial pressure 2,000 pounds). A comparison of this graph with Figure 3 shows no changes in the shape of the curve.

mental results gathered during previous experimental and clinical work on submersion (to appear shortly) have been used in this investigation.

1 Mechanical efficiency of the apparatus. The function of the apparatus was first checked by graphs taken with mercury and chloroform manometers. For this purpose the mask of the apparatus was connected with a rubber bag representing the lung (Fig 2). In the two tubes leading from the apparatus to the mask were interposed two T tubes, 1, 2 the vertical branches of which were connected with a Y tube 3 which was connected with two manometers, one chloroform and the other mercury. Thus the tubes of the apparatus, 4, 5 were connected with the bag and the manometers.

The study of the graphs taken with this arrangement (Fig 3) showed that the up and down strokes representing positive (upward) and negative pressures were perfectly regular, their heights above and below the basal line were equal and their spacing the same.

The graph of Figure 3 gives a clear idea of the functioning of the apparatus. At the start the pressure is slightly positive for a short while 1 to 2 (Fig 3A), then it rises

when instead of plain oxygen, this author used 4 and 6 per cent of carbon dioxide in oxygen mixtures all other conditions of the experiment being the same, the changes in venous and arterial pressures were much less marked. Figure 6, represents the results obtained by using, respectively: pure oxygen (right end of the curve), and 4 and 6 per cent mixture of carbon dioxide in oxygen (middle part of the curve *b* and *c*). The fall of arterial and the rise of venous pressures during hyperpressures, sharply marked when the dog was breathing pure oxygen, *a*, are hardly noticeable or absent when carbon dioxide in oxygen mixture was given, *b*, *c*. In all these experiments the dog was curarized and anesthetized with chloral.

Rost reports that animals anesthetized with ether or chloral did not present any untoward after-effects following prolonged application of hyperpressure or hypopressure. Application of the same technique on the human did not show any untoward effects. Electrocardiograms taken at the end of the experiment showed no changes.

In our experimental study 7 dogs, of 10 kilograms average weight, were submitted to the action of the apparatus. They were all anesthetized by sodium amytal (55 milligrams per kilogram intraperitoneally, 10 per cent solution) or with ether. The duration of the experiments varied from 1 to 8 hours without interruption. No intratracheal cannula or air-way was used.

When the action of the apparatus did not last over 1 hour and 30 minutes, there was no period of apnea when the mask was disconnected, and the animal immediately resumed normal breathing. On the contrary, when the action of the apparatus was prolonged for 6 hours and over, there was often a period of apnea. In one animal (dog 22, 7 hour experiment) apnea lasted 4 minutes and 11 seconds. In another animal (dog 23, 6 hour experiment) apnea lasted 1 minute and 40 seconds. In both, normal respiration resumed spontaneously and proceeded normally.

In dogs 26, 27, and 28, on the contrary, with duration of the experiment of, respectively, 3 hours and 20 minutes, 6 hours, and 4 hours, there was not the slightest apnea. In

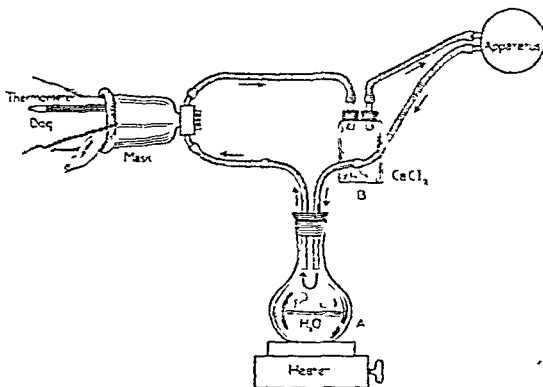


Fig. 7 Heating of gases going from E & J apparatus to the dog (Exp 28)

dog 24 the apparatus was connected with a tank of compressed air; in the others with a tank of 5 per cent carbon dioxide in oxygen mixture.

However, an important complication developed in the course of this investigation. Dogs 22, 23, 24, and 25 died between 12 hours and 5 days after the experiment although blood pressure and pulse rate had come back to normal. At the autopsy relatively slight pulmonary or other lesions were found, which could not explain death. Figure 1 shows the lung of the most affected of these animals (dog 22). Suspecting chilling as a possible cause of these deaths because the rectal temperature in all these dogs had dropped to around 31 degrees C. at the end of the experiment, we endeavored to avoid loss of heat and to maintain the body temperature around 38 degrees C. rectally. Dogs 25, 27, and 28, in which such precautions were taken, did not show the slightest trouble following the experiment. Dog 25 especially in which a heating and humidifying device of the gas mixture was used (Fig. 7.) showed the most uneventful recovery.

I deem it of interest to give here a short résumé of the protocols of these animals.

Experiment 22 Male dog, 12½ kilograms. The action of the resuscitator was prolonged for 6 hours. Carbon dioxide in oxygen, 5 per cent was used. When the resuscitator was disconnected the animal presented apnea which lasted 4 minutes and 11 seconds. Respiration continued normal thereafter. However, the animal was deeply in shock, with corneal and light reflexes absent. This animal was

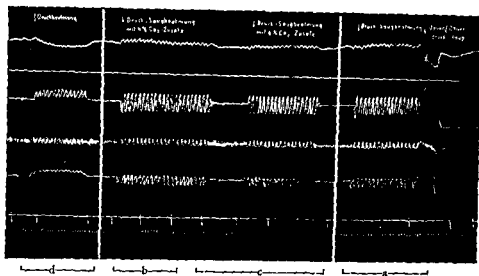


Fig. 6 Same experiment as in Figure 5 showing that the effects of intrapulmonary hyperpressure and hypopressure upon arterial and venous blood pressure are much less marked when instead of pure oxygen a mixture of oxygen carbon dioxide was used

out experimental work on dogs in order to test whether positive intrapulmonary pressures were likely to cause abnormal resistance to circulation and heart failure. They found that when the lung was inflated with air under pressure to or above 80 millimeters of mercury and this pressure was sustained for 10 seconds, there was considerable fall of the systemic arterial pressure while the venous pressure increased. In one experiment, in which the intrapulmonary pressure was brought to 80 millimeters of mercury the arterial pressure fell from 150 millimeters of mercury to 26 millimeters of mercury and the venous pressure rose to 120 centimeters of water. On releasing the intrapulmonary pressure the arterial pressure gradually returned to 128 millimeters of mercury, reaching this level within one minute. Haldane commenting on these findings says "It is obvious that high intrapulmonary pressure could not cause heart failure in consequence of an abnormal strain thrown on the right ventricle owing to excessive resistance to the outflow of blood from it, because there was little or no blood entering the ventricle to be pumped out ward."

A thorough experimental work was carried out by Rost (1932) on the effects of intrapul-

monary hyperpressure and hypopressure in dogs. In Figure 5, representing a graph of this author, are registered the results of hyperpressure (20 centimeters of water) and hypopressure (-20 centimeters of water) on a dog anesthetized with chloral and curarized. In this graph are recorded from up down, arterial pressure (femoral artery), intrapulmonary pressures (tracheal cannula), venous pressure (jugular vein), venous blood flow and time in seconds. It is clearly shown in this graph that as the intrapulmonary pressure is raised venous pressure rises and arterial pressure falls. The fall of the former being proportionate to the duration of the intrapulmonary hyperpressure. When the intrapulmonary pressure was decreased to -20 millimeters of water the arterial rose and the venous pressure dropped. The second period of hyperpressure in this curve was prolonged for 60 seconds. The arterial pressure showed a much greater drop even then, however, immediately after release of the intrapulmonary pressure both arterial and venous pressures were restored to normal. Continuation of this experiment for over an hour did not produce any damage to the lung or to the circulation nor was the flow of the venous blood influenced. It is of importance to note that

when instead of plain oxygen, this author used 4 and 6 per cent of carbon dioxide in oxygen mixtures all other conditions of the experiment being the same, the changes in venous and arterial pressures were much less marked. Figure 6, represents the results obtained by using, respectively, pure oxygen (right end of the curve), and 4 and 6 per cent mixture of carbon dioxide in oxygen (middle part of the curve *b* and *c*). The fall of arterial and the rise of venous pressures during hyperpressures, sharply marked when the dog was breathing pure oxygen, *a*, are hardly noticeable or absent when carbon dioxide in oxygen mixture was given, *b*, *c*. In all these experiments the dog was curarized and anesthetized with chloral.

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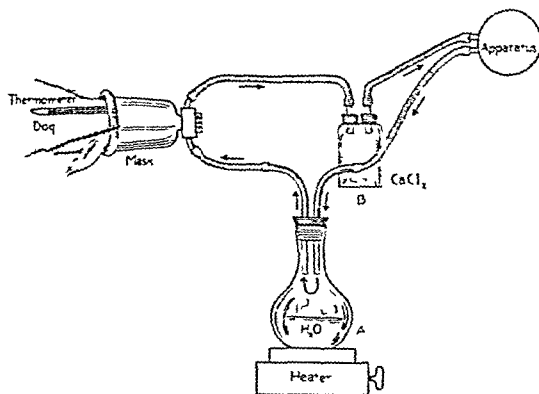


Fig 7 Heating of gases going from E & J apparatus to the dog (Exp 28)

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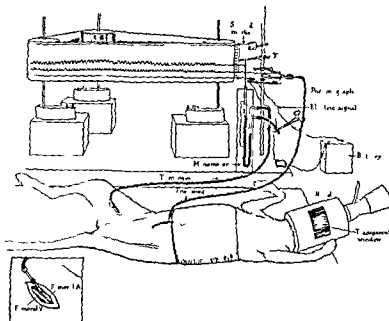


Fig. 8 Technique of experimental study in asphyxia submersion. The head of the dog previously anesthetized, was introduced into a metallic cylinder the hood. One base of this cylinder was closed by a rubber membrane perforated in its center. To the other base of the cylinder was soldered a funnel like device through which water could be poured into the hood. The neck of the animal was shaved and anointed with petrolatum. The hole in the rubber membrane was slightly stretched and the head of the animal passed through it. Thus the base of the hood was closed watertight and the head of the animal could be submerged by filling the hood with water. No undue structure was exerted upon the neck of the animal. A pneumograph was applied on the chest of the animal and a cannula was introduced into the femoral artery. This technique allowed continuous recording of respiratory movements and blood pressure.

found dead the next morning about 10 to 12 hours after the experiment. Autopsy showed light consolidation in the left lower and partial consolidation of the left upper lobe and right leaf of the accessory lobes as shown in the photograph of the specimen (Fig. 1).

It was thought that the animal probably died from oxygen pneumonia since he was breathing in an atmosphere of 95 per cent oxygen and in this instance the partial tension of oxygen in the mixture was 722 millimeters of mercury instead of 149 millimeters of mercury as in atmospheric air.

Histological section showed pulmonary congestion with moderate edema in the areas of consolidation.

However, the rectal temperature of this animal at the end of this experiment was 31 degrees C instead of 39 degrees C which is normal for the dog. This subnormal temperature was attributed to the rapid evaporation taking place in the lung to the low tempera-

ture of the gases, and the immobility of the anesthetized animal. Moreover, since the gases were dry, they might have caused pulmonary irritation by their dehydrating effect.

For the solution of this problem the following experiments were carried out.

Oxygen carbon dioxide mixture was replaced by plain compressed air in order to confirm or rule out oxygen pneumonia.

Experiment 23. Male dog 10½ kilograms. Sodium amytal was given intraperitoneally 55 milligrams per kilogram. The apparatus was connected with a tank of compressed air.

This experiment was carried out for 6 hours, all other conditions being the same as for experiment 22. The animal's temperature at the end of the experiment was again 31 degrees C. The animal presented apnea when the resuscitator was disconnected. Its duration was 1 minute and 40 seconds. This animal died 11 hours after the experiment.

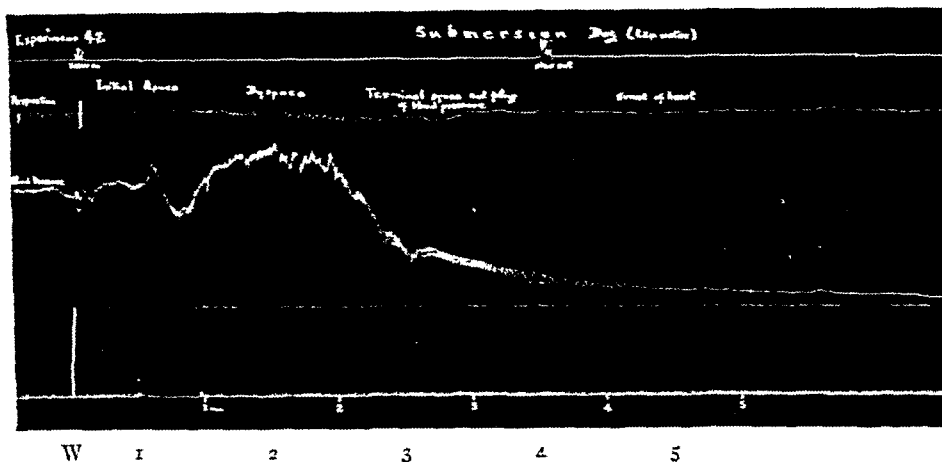


Fig 9 Graph of submersion in water (dog, technique of Fig 8) showing the four phases of asphyxia in submersion. Upper curve, respiration, lower, blood pressure. W, Water was poured into the hood. It is followed by reflex arrest of respiration (initial apnea) and elevation of blood pressure. 1-2, first phase, duration 1 minute. 2-3, Respiration becomes irregular and blood pressure continues to rise—second phase, of dyspnea, duration 1 minute. From 3-4 respiration gradually stops and blood pressure drops rapidly—third phase of terminal apnea, duration 1 minute. 4-5, Drop of blood pressure continuous and at the end the heart stops—fourth phase of arrest of the heart.

Autopsy showed again slight marginal consolidation which could not be the cause determining death.

Thus the cause of death in the previous experiment (dog 22) was not necessarily oxygen pneumonia.

The above findings were further verified by two additional experiments:

Experiment 24. The action of the apparatus was prolonged for 1 hour, using carbon dioxide in oxygen (95-5 per cent). Dog, 9½ kilograms, anesthesia with amytal 50 milligrams per kilogram. The rate of the apparatus was 15 per minute. Gas pressure in tank was 1700 pounds. Other conditions were the same as in experiments 22 and 23. The rectal temperature at the end of the experiment was 32 degrees C. These animals presented no apnea. Ocular and corneal reflexes were normal, anus only slightly patent. The last day of life the dog appeared rather sick. He died 5 days later. Postmortem examination revealed no appreciable pulmonary lesions.

Experiment 25. Dog, 9 kilograms. Sodium amytal anesthesia, 50 milligrams per kilogram body weight. The apparatus was connected with a tank of carbon dioxide in oxygen (95-5 per cent), initial pressure in tank was 1800 pounds. This experiment lasted 3½ hours. Again, at the end of the experiment the temperature had dropped to 31 degrees C. The animal died within 10 hours. At autopsy no sizable lesions of the lung were found.

These experiments suggested that the cause of death might have been related to an excessive chilling of the animals. It was therefore

interesting to prevent chilling, eliminate drop of temperature, and see whether death could be prevented, all other conditions remaining the same.

Three experiments were carried out:

Experiment 26. Dog, 18 pounds. Amytal, 55 milligrams per kilogram of body weight. This experiment was conducted exactly as experiments 22, 23, 24, and 25, the only differences being that measures were taken to prevent a drop of temperature by covering the animal with several blankets between which an electrically heated pad was placed. Rectal temperature was maintained constant between 38.5 and 39 degrees C. (readings taken every 5 minutes). Rate of the resuscitator was 20 per minute. Initial pressure in the tank was 1300 pounds. Carbon dioxide in oxygen mixture 5 per cent. Action of the apparatus was prolonged for 3 hours and 20 minutes. At the end of the experiment there was no apnea. Corneal reflex was active. Reflexes to light normal; anus contracted. Animal was out of anesthesia 2 hours after the end of the experiment, up on his feet, and he ate and drank. This dog remained in perfect condition.

Experiment 27. Apparatus was connected with a tank of compressed air as in experiment 25. Duration of experiment 6 hours. Dog, 8 kilograms: anesthesia with sodium amytal, 55 milligrams per kilogram body weight. Rate of apparatus 18 per minute. This rate was obtained by turning down clockwise the regulating valve of the apparatus so that the gases were turned off more than half. The animal's own respiration rate before the mask was applied was 14 per minute. Rectal temperature was main-

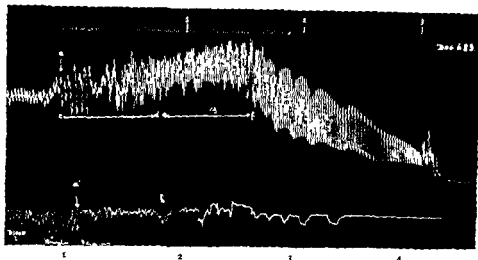


Fig 20 Similar experiment as in Figure 9 As in that graph the four phases are clearly shown

tained at 38.5 degrees C. Pressure in the tank at the start of the experiment was 2000 pounds. At the end of the experiment it was 450 pounds. No apnea occurred and the animal was up and about 3 hours after the end of the experiment. He remained in perfect condition.

The above experiments (26 and 27) have shown conclusively that the death of dogs 22, 23, 24, and 25 was not due to oxygen pneumonia and the hypothesis of death caused by excessive chilling was corroborated. In fact, when the loss of heat was prevented the dogs were able to stand 6 hours of continuous action of the resuscitator, using a 95-5 per cent carbon dioxide in oxygen mixture or compressed air without any evil after effect.

This question of death due to the lowering of the temperature of the animal was of particular interest. Therefore, in order to eliminate any possible error, in the following experiment (dog 28) the gases were heated and humidified before being led into the mask, by passing through a two-tubed bottle containing water heated to about 100 degrees C (Fig 7). The animal was not covered with blankets and electric pad. The protocol of this experiment follows.

Experiment 28. Male dog weight 25 pounds. Sodium amytal was given intraperitoneally 55 milligrams per kilogram body weight. Apparatus connected with carbon dioxide in oxygen (95-5 per cent). Layout of experiment as in drawing (Fig 7).

A large bottle containing water which could be heated was interposed in the insufflation tube of the E & J resuscitator and a similar bottle containing calcium chloride was interposed in the suction tube going from the mask to the machine. Thus the gases going to the mask were heated and humidified while the moisture in the gases coming from the mask was intercepted in bottle B in order to avoid possible damage to the apparatus. The temperature of the gases in the mask was checked by a thermometer tipped under the mask. The temperature of the body was recorded by another thermometer in the rectum. The duration of this experiment was exactly 4 hours 21 cubic centimeters more of 10 per cent solution of amytal was given during this time to maintain the animal under anesthesia. The temperature in the mask varied from 37 to 30 degrees C and was regulated by turning the heater on or off. Rectal temperature stayed 38 degrees C throughout the experiment. Pressure in the gas tank was 1500 pounds at the start and 100 pounds at the end of the experiment. The rate of the apparatus was 12 at the beginning, 14 in the middle of the experiment and 24 during the last 5 minutes of the experiment. There was no apnea at the end of the experiment.

The stomach of the animal was slightly distended at the end of the experiment. Corneal and light reflexes were present and very active. Three hours later the animal was on his legs and able to eat and drink. The next day the animal was normal and remained in good condition.

MECHANICAL RESUSCITATION

All students of asphyxia and resuscitation agree that the general term of "asphyxia" is a vague, confusing and often misleading term. In fact, as it will be presently shown,

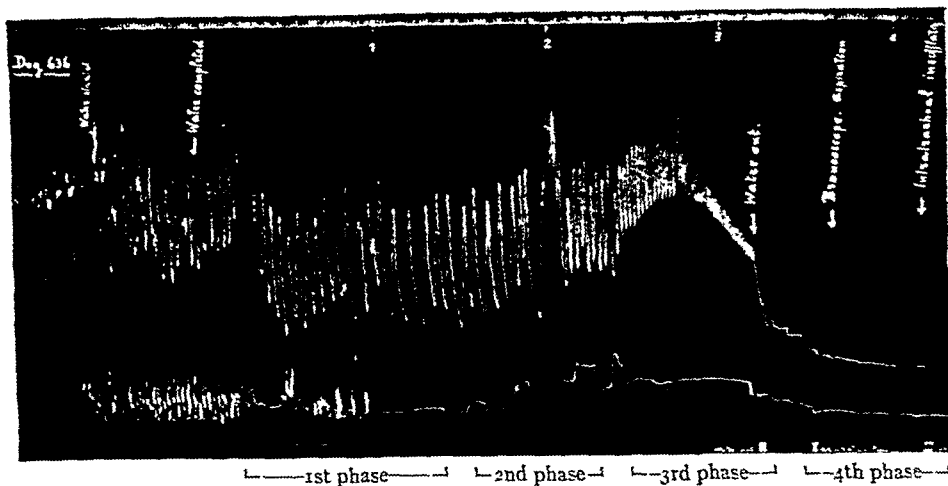


Fig. 11 Failure of attempt at resuscitation in submersion. The hood was removed at the end of the third phase. Blood pressure continued to drop. Bronchoscopic aspiration of fluid was applied 30 seconds after removal of hood, and intratracheal insufflation 30 seconds later without any result.

asphyxia, whatever its origin may be, is composed of four distinct phases which follow one another but they present different symptoms and different prognoses. Thus, for example, while resuscitation is very easy at the first and second phase, it becomes difficult at the beginning of the third phase, very difficult at the middle of this phase, and quite impossible at its end, and in the fourth phase. Therefore when the question of resuscitation is discussed and especially when the merits of the different procedures are appraised and compared, it is absolutely necessary to indicate with the greatest accuracy not only the phase but also the period of the phase of asphyxia in which the reported results were obtained. Reports and conclusions in which this point has not been strictly observed are deprived of any scientific value. I believe that is because this point has not been sufficiently stressed so far that so many contradictory opinions are held today upon the different methods of resuscitation. This contention is backed by our experimental data which are reported here.

The most commonly encountered forms of asphyxia belong to one of the following three groups: (1) Resistance to respiration, such as submersion in water, bronchial obstruction or combination of both as when the lung drowns in its own exudate; (2) vitiation of the respired air, such as oxygen want, or in breath-

ing of anesthetic or neutral gas, or carbon monoxide poisoning, (3) disturbances of the respiratory center as in electric shock and possibly traumatic or postoperative shock.

It is not in the scope of this paper to enter into the details of resuscitation in all these forms of asphyxia. Thus resuscitation in carbon monoxide poisoning and of the newborn shall not be considered. I shall study asphyxia and resuscitation only as regards submersion, bronchial obstruction, and anesthesia—the forms of asphyxia of the greatest interest both to the thoracic surgeon and to the anesthetist.

Asphyxia by submersion. Asphyxia by submersion has been studied experimentally by means of a special technique which has rendered possible accurate and continuous recording of respiration and blood pressure throughout the entire duration of submersion. Flagg, Birnbaum, and I have devised a method during our studies on submersion which gave us valuable information. Our experimental findings were checked upon human cases of submersion which we had the opportunity to study on the beach of Coney Island during the summer of 1933.

Technique. Thirty-two dogs were used for these experiments, weighing around 10 pounds. The animals were anesthetized with sodium amytal, 10 per cent solution, injected intraperitoneally. Fifty-five milligrams per



Fig. 12 Spontaneous resuscitation in submerison. The hood was removed 15 seconds before the end of the third phase.

kilogram of body weight was given. In a small number of dogs ether anesthesia was used instead.

The neck of the animal was shaved and anointed with petrolatum. A special hood had been constructed, of light metal, representing a cylinder 10 inches long and 6 inches in diameter. One base of this cylinder was closed with a diaphragm of rubber tissue in which a central opening was made. On the other base, a smaller and funnel like cylinder was soldered. In the middle of the hood a hole was made which was closed, and kept water tight by a sheet of celluloid and served as an observation window. A pneumograph was applied on the chest of the animal and was connected with a recording tambour. The femoral artery was cannulated and the

cannula was connected with a recording mercury manometer (Fig. 8).

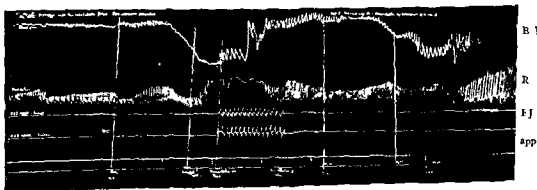
By slightly stretching the opening of the diaphragm of the hood it was easy to pass through it the head of the animal down to its neck. Thus the head was contained in a cylinder the bottom of which was water tightly fitted around the neck without exerting any undue pressure upon it.

Thus during the experiment it was possible to register on the smoked drum respiration, blood pressure, times in seconds and the oscillations of the resuscitation apparatus.

For producing asphyxia by submersion water was poured into the cylinder which was filled up until mouth and nostrils of the animal were completely under water. This technique rendered also possible the study of submersion in different medias. Interesting differences were noted when the animals were submerged in tap water, isotonic, or hypertonic salt solution. Moreover it was possible to interrupt instantly submersion or even to administer oxygen or carbon dioxide in oxygen by means of an intratracheal catheter while the mouth and nostrils of the animal were under water.

We shall report here the more interesting points of our findings.

Figures 9, 10, and 11 show the course of asphyxia by submersion in tap water. The whole phenomenon from its beginning to the death of the animal presented a remarkably constant duration of 4 to 5 minutes. This



A.R.

Fig. 13 Attempt at resuscitation in submersion with F & J apparatus. End of third phase. Successful. The hood was removed at the end of the third phase. Manual

artificial respiration was applied. A.R. without result. F & J apparatus was then used for 90 seconds with success. Blood pressure rose, spontaneous respiration resumed.

course was clearly divided into 4 distinct phases, each of 1 minute duration. These phases can be described as follows (Fig 9).

The first phase is characterized by apnea and rise of blood pressure. This apnea is due to the reflex closure of the glottis. I shall call it the phase of initial apnea. Rise of blood pressure at the beginning of asphyxia is a constant phenomenon in all forms of asphyxia. The duration of this phase is of about 1 minute.

The second phase is characterized by labored respiratory movements and continuation of the rise of blood pressure. The animal fights for breath; the non-anesthetized animal is perfectly conscious until the end of this phase and fights vigorously to liberate itself of the hood. At the end of this phase, which lasts also 1 minute, consciousness disappears and tonic and clonic convulsions appear. This phase can be called the "phase of dyspnea."

The third phase is characterized by arrest of respiration, drop of the blood pressure, and disappearance of reflexes and muscular tonus. The duration of this phase is also of 1 minute. The animal which presented clonic and tonic convulsions at the end of the second phase, gradually relaxes and becomes limp, its jaw drops, the sphincters relax and the corneal and glottis reflexes disappear. I shall designate this phase as the phase of "terminal apnea."

The fourth phase is characterized by rapidly progressing weakness of cardiac contraction and arrest of the heart. I shall indicate this phase as phase of arrest of the heart. The same phases are seen in Figures 10 and 11.

The prognosis is very different in each of these phases; in fact when submersion is interrupted anywhere before the middle of the third phase immediate and spontaneous resuscitation always follows (Fig. 12); on the contrary, in the third phase (phase of terminal apnea) resuscitation which is still easy when submersion is interrupted at the beginning of this phase becomes increasingly difficult as we approach the end of this phase. Figure 11 illustrates this point. Although the hood was removed at the end of the third phase asphyxia progressed to the fourth phase and the heart stopped. Neither artificial respiration nor bronchoscopic intratracheal insufflation succeeded in resuscitating this animal.

The graph, Figure 13, is of considerable interest because it shows that resuscitation can be obtained in this phase by the use of the E & J apparatus when it is applied without any delay. The hood was removed at this experiment, as in experiment of Figure 11, at the end of third phase. Artificial respiration was without any response. On the contrary within 20 seconds after the application of E & J apparatus blood pressure rose almost vertically and the animal was brought back to life.

This experimental evidence shows clearly, I believe, the importance of dividing asphyxia by submersion into four phases. Moreover, it shows the futility of artificial respiration and carbon dioxide in oxygen inhalation beyond the third phase and the necessity of avoiding any loss of time by the immediate application of procedures which insure insufflation of oxygen.

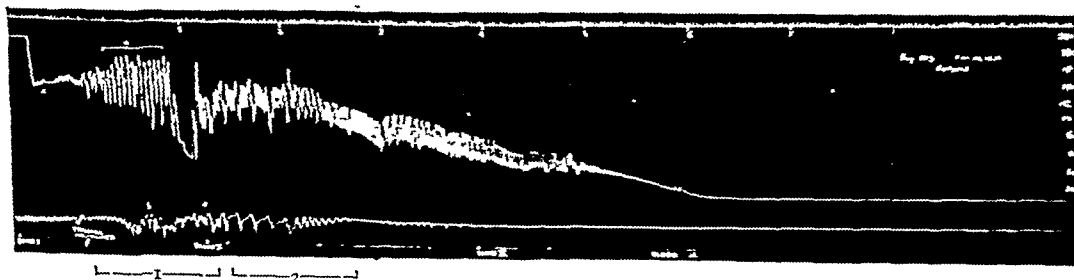


Fig 14 Graph of asphyxia by obstruction of trachea in the dog, upper curve, blood pressure, lower respiration. In 1 the trachea was only partially obstructed, blood pressure was very slightly affected. At 2 obstruction was made complete. Blood pressure rose for 1 minute while

respiratory movements became irregular—second phase. Then blood pressure began to drop and respiration ceased—third phase. Gradually heart stopped—fourth phase. Resuscitation was attempted without success at the fourth phase.



Fig 15 Asphyxia by tracheal obstruction. Spontaneous resuscitation. Obstruction was removed at the end of third phase before the beginning of the fourth phase. It

was found that the blood pressure rose immediately and that spontaneous respiration was resumed 20 seconds later.

into the lung. The fact that resuscitation is still easy at the beginning of the third phase while it is very difficult and often impossible at the end of the same phase and that the duration of this phase is of 1 minute only, shows clearly the paramount importance of time. Seconds count in asphyxia and often determine the life or death of the patient. This experimental evidence illustrates the statement previously made that unless the phase of asphyxia is accurately indicated in the results obtained with different procedures of resuscitation, no reliance can be placed upon the results reported.

The division of asphyxia into four phases is also evident in bronchial obstruction and in breathing of neutral or anesthetic gases (oxygen want).

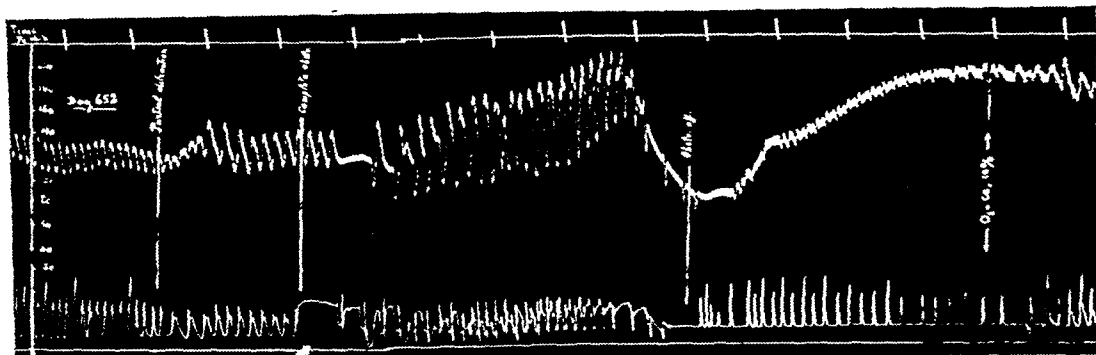
Asphyxia by bronchial obstruction. Eighteen dogs were used for these experiments. Bronchial obstruction was obtained by introducing into the trachea, through the bronchoscope a small balloon attached to a fine brass tube. This balloon could be inflated from the outside and thus produced obstruction either of the trachea or of a common bronchus. The advantages of this technique are that complete obstruction can be obtained without any traumatism to the animal, that the degree of obstruction can be regulated at will and that it can be established or interrupted instantly.

The curve of asphyxia by complete obstruction of the trachea is very similar to the curve of submersion (Fig 14). The four phases are clearly shown namely initial apnea, dyspnea, terminal apnea, and arrest of the heart. Again the duration of each phase is of

about 1 minute and death occurs within 4 to 5 minutes.

Removal of the obstructing agent before the end of the third phase is followed as a rule by immediate spontaneous resuscitation (Fig 15). On the contrary, when obstruction is released later artificial resuscitation is generally necessary in order to obtain resuscitation (Fig 16). In a general way, however, resuscitation is easier in bronchial obstruction than submersion. The reason is obvious, removal of the obstructing agent instantly establishes the patency of the air passages in uncomplicated bronchial obstruction while in submersion alveoli, smaller bronchi, and even larger bronchi may be filled with water. On the other hand, it should not be forgotten that there are cases of submersion in which very little water has penetrated into the lung, while, there are cases of bronchial obstruction in which the lung is filled up with bronchial secretions representing the "drowned lung" of Leopold. These little known details explain the peculiar variations in resuscitation; they must be borne in mind in the appreciation of the causes of success or failure and of the therapeutic indications in each individual case.

Partial obstruction causes little changes in the curves of respiration and blood pressure (beginning of curve Fig 14). It is surprising how little air is often sufficient to prolong life. This point is of paramount practical importance because it shows the necessity of insuring at once even partial patency of the upper respiratory ways. Suction of exudate present in the larynx, traction of the tongue and especially introduction of intratracheal catheter



↑ E & J app

Fig 16 Asphyxia by bronchial obstruction. Resuscitation by the E & J apparatus applied at the end of the third phase. From up down, times in $\frac{1}{2}$ minutes, blood pressure and respiration. Obstruction of trachea was released at the

end of the third phase. E & J apparatus was applied 20 seconds later. Blood pressure continued to drop for 30 seconds, it remained low for 30 more seconds, and then rose to slightly above normal.

when performed timely and skillfully, increase considerably the chances of resuscitation.

It is obvious that in asphyxia by tracheal obstruction or submersion, artificial respiration by the Shaeffer or Sylvester methods combined with carbon dioxide in oxygen inhalation will be successful as long as they are applied on patients with patent respiratory ways and before the end of the third phase. After this phase rhythmic insufflation and suction of air into the lung are incomparably more efficient. Figure 16 shows resuscitation obtained by the application of E & J apparatus, 1 minute after complete drop of the blood pressure, with heart beats hardly visible, that is almost at the fourth phase.

These two forms of asphyxia, by submersion and bronchial obstruction, are of great practical importance to the anesthetist and the thoracic surgeon. In fact, the great majority of deaths following thoracic operations for pulmonary suppuration are due to their combination. In these cases the patients die because of restriction of the respiratory field, with or without bronchial obstruction, by the bronchial exudate retained in the bronchial tree. From the evidence herein offered it becomes obvious that the only rational treatment in these cases consists in the rapid suction of this exudate by means of intratracheal catheter followed by rhythmic insufflation of carbon dioxide in oxygen, either by mouth-to-mouth insufflation or better by means of an apparatus. Moreover, preventive measures in

these cases are of the greatest importance. Careful pre-operative removal of bronchial secretion by cough and postural drainage, and the use of intratracheal catheter during operation in all patients who expectorate over 30 cubic centimeters in 24 hours are lifesaving measures. It was shown elsewhere that aspiration of bronchial secretion before and after thoracoplasties in pulmonary tuberculosis have considerably decreased both morbidity and mortality in these cases.

Asphyxia by respiration of neutral or anesthetic gases. Asphyxia was produced experimentally by breathing of hydrogen, nitrogen, and helium. Seven dogs were used in these experiments, 2 with hydrogen, 2 with nitrogen, and 3 with helium.

The curves of these forms of asphyxia are identical with the curves of submersion and bronchial obstruction, with the only difference that the phase of initial apnea is less marked in them and occasionally absent. Figures 17 and 18 represent respectively the curves of asphyxia by overdose of ether and breathing of helium. Again we found in these curves as in the previous ones, the characteristic drop of blood pressure at the third phase followed by arrest of the heart within 5 minutes after the beginning of the experiment.

These two curves (Figs 17 and 18) should be studied more closely because they show in a remarkable way, and for the first time as far as I know, the importance and efficiency of massage of the heart in resuscitation even



Fig 17 Resuscitation in asphyxia by overdose of ether Combined action of E & J apparatus and direct massage of the heart 1 fourth phase arrest of the heart—0 minute after respiratory arrest 2 E & J apparatus was put in action (2 minutes after arrest of the heart) Manual

artificial respiration was without any effect M, Direct massage of the heart repeated at M and M' followed by resuscitation about 9 minutes and 50 seconds after complete arrest of respiration and 0½ minutes after arrest of the heart (See text)

over 10 minutes after complete arrest of the heart provided that the lung had been maintained adequately ventilated

Resuscitation obtained after the fourth phase by combined mechanical pulmonary ventilation and massage of the heart Two of these experiments are reported here

Dog 18 Male 13 kilograms (Fig 17) This dog was given ether until drop of blood pressure (third phase) had occurred and the heart stopped (fourth phase) E & J apparatus was applied 6 minutes after respiratory arrest and 2 minutes after arrest of the heart For 4 minutes no changes were noticed in the heart or the blood pressure Nine minutes and 50 seconds after the onset of apnea and 6½ minutes after arrest of the heart the abdominal wall was incised and the hand was introduced into the chest cavity through the diaphragm the heart was grasped and massaged slowly On the graph the massage was distinctly visible and is indicated by the letter M Following the second massage of the heart a few cardiac contractions were felt which are seen on the graph Following a third attempt the heart started beating regularly and vigorously The animal was brought back to life

Dog 10 Male, 18 kilograms Anesthesia was effected with amylal 10 per cent intraperitoneally 55 milligrams of amylal per kilogram body weight

This animal was given pure helium to breathe (curve Fig 18 A and B 18B being the continuation of 18A) The animal entered the third phase 3½ minutes after the onset of the experiment and 1 minute later (4½ minutes after the onset of this experiment) there was terminal apnea and arrest of the heart E & J apparatus was applied at the sixth minute Rhythmic compression of the chest was

used at same time without any effect upon heart At the eleventh minute (6 minutes after apnea and 5 minutes after arrest of the heart) a long abdominal incision was made and the hand was introduced into the chest through an opening made in the diaphragm Seven times the heart was massaged once every minute at the eleventh, twelfth, thirteenth, fourteenth, sixteenth, seventeenth and eighteenth minute Each time there was a response of the heart which was becoming progressively stronger and longer, as it is clearly shown in the graph At the twentieth minute (15 minutes after arrest of the heart) the heart started beating again blood pressure rose and spontaneous respiratory movements were re established

These two experiments show that massage of the heart as a method of resuscitation in desperate cases of asphyxia may be successful, provided that the pulmonary blood had been maintained adequately ventilated It is my contention that pulmonary ventilation is a compulsory factor for the success of massage of the heart It is reasonable to admit that unless the blood pumped into the heart and forced into its coronary vessels by massage of this organ be adequately oxygenated, no resuscitation of this organ can take place

These experiments are of considerable practical importance They prove that massage of the heart should be accepted as a legitimate procedure for resuscitation, more over that immediate application and continuation of mouth to mouth or mechanical

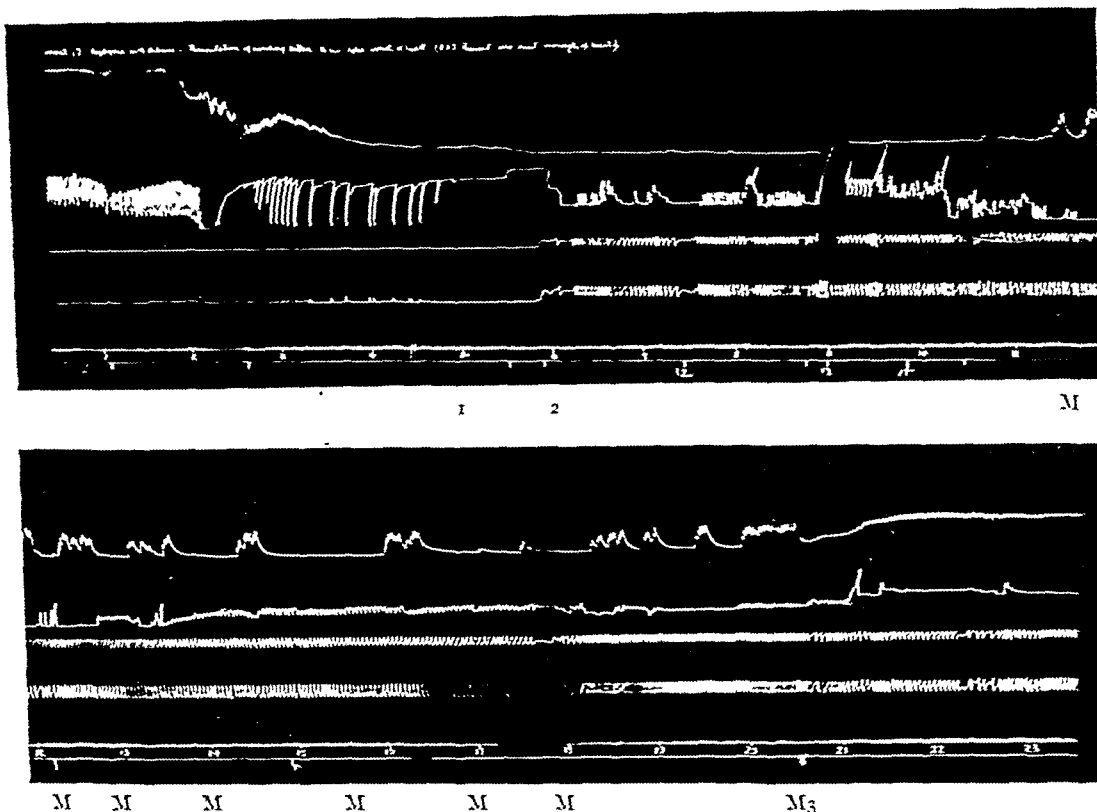


Fig 18 A and B. B, the continuation of B. Resuscitation in asphyxia by helium. Combined action of E & J respirator and direct massage of the heart. Arrest of the heart at the fifth minute, 1. Respirator was put in action

at the sixth minute. 2. M M, massage of the heart, each massage being followed by a faint response of the heart. At 3, 15 minutes after arrest of the heart spontaneous beats had resumed and blood pressure rose (See text.)

insufflation gives enough time to surgeon to enter into the chest either through the abdominal cavity or through the fourth intercostal space, with all aseptic precautions. If my interpretation of data presented is correct, massage of the heart should be recognized not only as a legitimate procedure but as a compulsory one in advanced cases of asphyxia.

Action of E & J apparatus in open chest operations. The behavior of dogs, with wide open chest, in which respiration was insured by the resuscitator was investigated in 13 animals. On these animals were performed ligations of the pulmonary vessels, lobectomies, pneumonectomies, wrapping of lobes in rubber bags for the production of compressive atelectasis and ligation of the coronary vessels. All these animals resumed normal respiration after closure of the chest.

It must be noted that these operations were carried out in the dog with greater ease than with ordinary intratracheal insufflation because relatively slight expansion and retraction of the lungs were sufficient to insure adequate ventilation, thus the chest was not crowded by over expanded lungs and there was more room for the performance of the operations.

The following experiment illustrates that by using the E & J apparatus dogs can remain for a long time with the chest widely open without showing any marked disturbances of respiration and circulation; when the chest was closed the animal immediately resumed normal respiration.

Experiment 33 Dog weighed 8 kilograms. Anesthesia given was amylal intraperitoneally. Chest was opened by section in the middle of the sternum,

ligation of bleeding vessels and wide retraction of the edges of the sternum by means of self retaining retractor. Mask connected with resuscitator. Resection of the right lung. After 2 hours the chest was closed in an air tight manner by means of clamps and resuscitation was discontinued. Spontaneous respiration was immediately resumed and the blood pressure rose.

Possibility of injury to the lung by positive intrapulmonary pressures. In order to investigate this point we used lungs of dogs removed immediately after death with care to prevent any injury to them. Manual handling of the lung was avoided. The lungs were separated from the heart after ligation of the pulmonary arteries and veins. The two tubes of the resuscitator were connected with a Y tube the vertical branch of which was solidly tight to the trachea as was the rubber bag in Figure 2. Under the action of the resuscitator the lung expanded and retracted rhythmically, with positive pressure of 14 millimeters of mercury it became only moderately distended. In order to produce rupture to the lung it has been necessary to connect the trachea directly with the faucet of compressed air of the laboratory, the lung was placed and maintained under water by a metallic net placed above the lung. Rupture of the lung and bubbling of air appeared only when the pressures reached between 52 to 58 millimeters of mercury. It is therefore impossible that a positive pressure of 14 millimeters of mercury can cause even the slightest traumatic lesion of the lung. On the contrary, when there is an advanced degree of collapse, as there is 5 to 10 hours after death of the animal, the lung can be only partially inflated by the positive pressure built by this apparatus. Therefore, it is reasonable to believe that clinically we may encounter collapsed lungs resisting adequate expansion with 14 millimeters of mercury positive pressure. For this reason we have advised the manufacturer to add a fool proof valve which could allow when and if necessary intermittent insufflations under a positive pressure of 20 to 30 millimeters of mercury.

It is true, however, that high positive intrapulmonary pressures above 50 millimeters can produce rupture of pulmonary alveoli often complicated by mediastinal and subcutaneous emphysema, pneumothorax, and even pneu-

moperitoneum. Intrapulmonary hemorrhage and cardiac or cerebral air embolism may also be produced by high intrapulmonary pressures.

Ewald and Robert (1883) had found that in rabbits when the pressure in the lung reached 40 millimeters of mercury, air could be detected in the abdominal cavity. Joannides (1931) produced pneumothorax, pneumoperitoneum, and even air embolism with intrapulmonary pressures of from 50 to 100 millimeters of mercury.

Polak and Adams (1932) have carried out a series of interesting experiments in dogs, in which arterial and venous pressures were recorded. They have introduced air under pressure into the trachea through a tracheal cannula. A special cannula was interposed in the carotid artery filled with normal saline which was arranged to act as a trap for any air bubbles which might be present in the blood or the artery. When they raised the intrapulmonary pressure to 60 millimeters of mercury for 10 seconds they observed the typical fall of arterial pressure and rise of venous pressure already described (Figs 4 and 5). No air bubbles appeared in the carotid trap with 60 millimeters of mercury pressure. Only when the intrapulmonary pressure was brought to 80 millimeters of mercury and maintained at this level for 10 seconds, numerous air bubbles appeared in the carotid trap. With 100 millimeters of mercury for 10 seconds still more air appeared in the carotid trap and the animal ceased to breathe though the heart continued to beat for 2 more minutes. At autopsy, besides extensive mediastinal and subcutaneous emphysema, interstitial emphysema was present around the pulmonary vessels and hemorrhagic areas were seen extending into the lung substance. Microscopically, vascular hemorrhages were found in the lung and air emboli were present in the coronary and mesenteric arteries and in vessels of the brain. Air was present in both ventricles. From their numerous experiments these authors concluded that no harm can be caused as long as the intrapulmonary pressure remains below 80 millimeters of mercury. But from 90 millimeters of mercury or more traumatic air embolism is likely to occur.

These experiments of Polak and Adams were carried out in order to explain embolism occurring in sailors carrying the submarine escape respiratory apparatus and rapidly rising from a depth of 15 feet or more. Haldane, commenting on their work said: "When a man comes up rapidly from a depth of even as little as 15 feet, with his mouth closed and without breathing, excess of intrapulmonary pressure over external pressure is built and it rises rapidly to a high figure. As soon as this pressure exceeds about 80 millimeters of mercury there is stretching and tearing of alveoli and their capillaries with the result that air is forced into these vessels; nothing of the kind occurs if the man is instructed to breathe during the ascension."

Therefore, we can conclude that no traumatism to the lung is possible even when positive pressures of 30 and 40 millimeters of mercury are used. It is fortunate that there is such a large margin of safety between the pressures necessary and sufficient for resuscitation and the pressures which are liable to cause rupture of alveoli, thus the lung may be forcibly expanded if it presents an advanced degree of collapse without any danger of injury.

In the light of the experimental evidence presented here I was forced to revise my previous unfavorable opinion of the automatic pulmotor principle. This opinion was based upon the conclusions of the reports in 1913 of the Commission of Resuscitation from Electric Shock (17) and of the Committee on Resuscitation from Mine Gases (18) in 1914. These conclusions were both edited by the secretary of this committee, Yandel Henderson. This author in numerous papers which have appeared since the publication of these reports has repeatedly and insistently expressed his distrust for all procedures of resuscitation based upon the principle of the automatic pulmotor of Draeger. I cannot agree with this author. The experimental work, only partially reported in this paper, has convinced me that the E & J apparatus is harmless and of great help in resuscitation. Therefore I thought that I was authorized to apply it to patients. This trial has justified my favorable opinion, as it is shown in the reports of a small number of human cases.

HUMAN CASES

This apparatus was used on 12 patients during or following operations for pulmonary suppuration. All had shown advanced asphyxia with apnea. The histories of 3 cases, 2 successful and 1 failure, are given here. A more extensive study of all cases will be given later in a special paper.

CASE 1. S. M., aged 28 years, white, female, was admitted to Sea View Hospital, January 15, 1935; readmitted June 9, 1936 No 11466-36. Diagnosis: right mixed infection tuberculous empyema; drained, left pneumothorax with adhesions. Sputum, Gaffky No 3.

November 24, 1936. Pneumonolysis of left apex. Successful Sputum turned negative for 2 months.

December 29, 1936. First stage thoracoplasty on right side. Total resection of three ribs. Cyclopropane anesthesia. Good recovery.

April 6, 1937. Second stage thoracoplasty, resection of fourth, fifth, and sixth ribs. Cyclopropane anesthesia. Patient strongly anoxicemic. Vital capacity 950 cubic centimeters. Intratracheal catheter was used.

Twenty minutes after beginning of operation patient became extremely cyanotic with shallow, rapid, and periodic breathing. Patient was given carbon dioxide in oxygen inhalation which improved her condition. At the end of the operation condition became worse—gray cyanosis, with shallow, irregular, and gasping breathing, fall of blood pressure—pressure could not be recorded in the sphygmomanometer. Heart was irregular. Stimulants and carbon dioxide in oxygen inhalation were without any effect. Suddenly respiration stopped, eyes were glassy, pupils half dilated and jaw relaxing.

Resuscitator was applied and kept on for 15 minutes. Immediate and striking improvement was noticed. Within 5 minutes heart beats became regular, pulse could be felt in the radial artery (140 per minute) and cyanosis cleared up considerably. Spontaneous breathing was re-established within 12 minutes. Resuscitation was stopped after 14 minutes. Patient made uneventful recovery.

CASE 2. H. L., white, female, aged 23 years, with bilateral thoracoplasty was admitted at Sea View Hospital June 4, 1936 No 1316-36. Bilateral ulcerative pulmonary tuberculosis. Sputum, Gaffky No 6.

Pneumothorax was attempted on both sides without success. Vital capacity 1200 cubic centimeters. Marked chronic anoxemia.

December 22, 1936. First stage thoracoplasty was done on left side, with cyclopropane anesthesia, resection of five ribs. During operation patient had repeated attacks of apnea but recovered with inhalation of carbon dioxide in oxygen and rhythmic pressures on the chest.

At the end of the operation respiration became very shallow and hardly noticeable; marked cyano-

sis, blood pressure fell rapidly and could not be recorded respiration ceased. Patient was in profound shock and complete relaxation. Heart beats could not be detected.

Mouth to mouth insufflation was instituted and resuscitator was applied. Within 7 minutes, color improved, blood pressure rose to 85 millimeters systolic and spontaneous respiratory movements were resumed. Inhalation of carbon dioxide in oxygen was then continued for 40 minutes until patient was awakened. Recovery was uneventful.

February 23, 1937. First stage thoracoplasty on right side with cyclopropane anesthesia. resection of four ribs. No shock. Course uneventful.

CASE 3. W. A. white aged 34 years. Patient was admitted at Sea View Hospital July 31, 1936. No 13941-36. Diagnosis: bilateral ulcerative pulmonary tuberculosis.

January 22, 1937. First stage thoracoplasty with resection of three ribs and apicolysis. Cyclopropane anesthesia was used. Postoperative course was smooth.

January 28, 1937. Sixth postoperative day spontaneous pneumothorax on right side. Deflation of 1100 cubic centimeters of air with marked relief. Patient was placed on continuous deflation.

February 1, 1937. Right lung partially re-expanded. The patient who had been comfortable for the last 3 days suddenly developed pain in left chest and extreme dyspnea with cyanosis. Diagnosis of obstruction of the left lower lobe was made in the x-ray film. An intratracheal catheter was introduced and the right lower bronchus was aspirated. Patient was improved immediately.

February 4, acute episode similar to that on February 1 occurred. An intratracheal catheter was introduced in the left bronchus and 20 cubic centimeters of thick mucus was aspirated. Patient was immediately improved. However 1 hour later a new attack of extreme dyspnea occurred, and when the resident physician arrived a few minutes later (no more than 5 to 7) patient was in apnea. Heart beats could not be elicited, pupils were dilated and lower jaw relaxed. Intracardiac adrenalin was given and mouth to mouth insufflation was instituted until the apparatus was brought in. Within 2 minutes after application of apparatus heart beats could be heard again but they were very rapid and faint. Bronchial suction was repeated but during action heart stopped again. Apparatus was re-applied and heart beats were established again. Occasional spontaneous respiratory movements were produced. After 30 minutes heart went into fibrillation and patient died. Direct massage of the heart through abdominal incision could not be resorted to because of lack of authorization. Patient died 1 hour and 40 minutes after last attack. At the autopsy no other cause of death was found outside of advanced atheroma of aorta. Right auricle and ventricle were moderately dilated and left heart hypertrophied.

These cases are typical examples of ad-

vanced forms of asphyxia with apnea in the presence of marked chronic anoxemia. In all these cases resuscitation began after the third phase. The results obtained show the importance, in such cases of immediate and energetic resuscitation, and the futility of simple inhalation with manual artificial respiration. In these cases the insufflation—suction apparatus and mouth to mouth insufflation—are the only methods which have given me satisfactory and often striking results.

SUMMARY AND CONCLUSIONS

The relatively frequent development of acute asphyxia complicating chronic anoxemia always present in cases with chronic pulmonary suppuration either during operations upon these cases or during the post-operative period, has rendered necessary the perfection of our procedures of resuscitation.

A long study clinical and experimental was carried out on dogs on humans drowned at Coney Island beach and on our patients operated upon for chronic suppurations of the lung, especially with advanced pulmonary tuberculosis and bronchiectasis.

Ample experimental evidence has shown that acute asphyxia should be divided into 4 phases. It was shown that during the first 2 phases and the beginning of the third resuscitation can be easily obtained with manual artificial respiration and inhalation of oxygen carbon dioxide 5 to 10 per cent as shown by Vandel Henderson. On the contrary in the third phase which is characterized by rapidly falling blood pressure ending in arrest of the heart (fourth phase) inhalation and manual methods are inadequate to insure resuscitation. Suppression of muscular tonus and apnea prevent any adequate ventilation of the blood by these methods.

Experience had shown that in these cases mouth to mouth insufflation has given by far the best results. Therefore, it was thought that an apparatus based on the automatic pulmotor principle, with constant pressure and variable volumes, could be useful in cases in which mouth to mouth insufflation was not applicable as in tuberculous or bronchiectatic patients.

An apparatus based on this principle was

selected (E & J apparatus) and submitted to exhausting experimental investigation. The results of this inquiry having been favorable, this apparatus was used upon human cases with satisfactory results.

It seems, therefore, that previously prevailing opinions against the principle of a rhythmic insufflation-aspiration must be revised. At any rate these opinions were not based, at least in the reports and papers published up to this date, upon any thorough experimental or even clinical evidence. On the other hand, it is peculiar that even in the papers of Henderson in which the principle of insufflation-suction is definitely condemned, intratracheal insufflation (procedure of Meltzer) is recommended for the resuscitation of stillborn infants.

The evidence presented in this paper has convinced me that while manual artificial respiration with oxygen-carbon dioxide inhalation are efficient procedures for non-advanced degrees of asphyxia (first to third phase) they become useless and even dangerous, because of loss of time, when asphyxia has reached the third and especially the fourth phase. In the presence of apnea and beginning relaxation of the muscular system, only methods insuring forcible insufflation of oxygen into the lungs can still produce resuscitation.

It should be understood that these two procedures should not be opposed to each other. They have their special indications and they complete one another. The automatic pulmotor principle, complements manual artificial respiration with inhalation in advanced asphyxia as the principle of passive expansion-contraction of the chest, utilized in the machines of Drinker and Emerson, is the only one suitable in cases of paralysis of the respiratory muscles.

In a general way mouth-to-mouth insufflation or mechanical insufflation-suction need be applied for a relatively short time and until spontaneous respiratory movements have been resumed. Resuscitation should be continued thereafter by the inhalation method until complete recovery. In cases of asphyxia with carbon monoxide, inhalation should be continued for a relatively long time.

Thus we come to the conclusion that the ideal mechanical contraption for resuscitation is an apparatus which combines an inhalator and a resuscitator. A simple inhalator represents only one half of such an apparatus. Therefore I am satisfied that the E & J apparatus is of a great help in mechanical resuscitation.

It is also my contention that this apparatus can cause no harm in the hands of non-medical but trained rescue squads. The fear of causing pulmonary, cardiac, or respiratory complications by rhythmic rise and fall of intrapulmonary pressure had not been corroborated either by my experimental and clinical investigation or by the studies of other authors.

Moreover, it was shown in the course of this work that in cases of asphyxia with apnea and arrested heart, resuscitation is possible by direct massage of the heart within 10 minutes from the time of arrest of the heart, provided that the lungs have been maintained actively ventilated.

Yandel Henderson has said recently that much still remains to be learned about asphyxia. It can be added to this wise remark that in order to learn it is necessary to free ourselves from cumbersome dogmatism and preconceived ideas. Only thoroughly checked experimental evidence and equally thoroughly controlled clinical facts must guide us in our statements and conclusions. Asphyxia has entered today the domain of everyday practice and its fundamentals should be well understood by anesthetist, surgeons and physicians, and adequate equipment for resuscitation should be made available for timely use.

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THE FERTILE PERIOD IN PRACTICE

A Five-Year Clinical Study

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IT is not my purpose in this article to enlarge the ever-increasing amount of technical data that are constantly broadening and changing our viewpoint of the phenomena of ovulation, conception, and pregnancy. But the avenues of thought, study, and research opened by work already accomplished are fascinating in the extreme, and the dimly seen possibilities of outstanding service to humanity urge every scientifically minded physician to add his bit to the still obscure phases of the problem.

Most of us cannot carry on the necessary research or laboratory and clinical procedure and I am, therefore, encouraged to note my own experience in actual practice, in the belief that every doctor can use some of the results of my more-or-less pioneering clinical efforts with the assurance of a successful outcome in practically all cases.

My interest in the fertile period and the physiological and biological discoveries that pointed to its existence began during a period of study in the Vienna clinics in 1931. There I first became acquainted with the work of Aschheim and Zondek, Ogino, Knaus, and others. Upon my return I began the regular use of the Aschheim-Zondek test for pregnancy, and developed a single injection method, using rabbits for test animals. This work was described in an article in *Medical World*, August, 1933. These efforts led to consideration of the fertility-sterility theory, which I hesitated to accept fully because I could not satisfy myself that the observed phenomena were based on a rational thesis.

INVESTIGATION OF THE SCIENTIFIC BASIS

In this quandary I began a thorough study of existing literature, including the latest and most pertinent data on the sperm cell, the egg cell, the ovary and the corpus luteum,

From the Miller Clinic

and the uterus and the pituitary hormones. The work of many investigators on the lower mammals, from the mouse to the monkey, was reviewed and verified. Nothing was taken for granted.

With the aid of Professor Thomas of the department of physics, Valparaiso University, hormones were extracted from female urine, and their action tested upon laboratory animals. Also with the technical aid of Professor Thruen of the chemistry department and Professor Elliot of the biology department, Valparaiso University, and the very generous help of the Methodist Episcopal Hospital, Gary, Indiana, the work of both Drs. Ogino and Knaus was repeated and checked.

There gradually appeared a rational premise for the existence of a fertile period in the menstrual cycle, and this was supported by all of the carefully verified evidence. It seemed advisable, therefore, to make actual tests and I commenced the application of the theory in a few cases, using the time intervals suggested by Knaus. The results of these efforts were most encouraging and were described by my associates and myself in *SURGERY, GYNECOLOGY AND OBSTETRICS*, June, 1933.

FIVE HUNDRED INDIVIDUAL CASES TESTED

From these early beginnings to the present time I have utilized the fertile period procedure in 500 private cases with excellent results. From time to time I have instituted such corollary procedures and changes as seemed necessary, and have tested various calendars and time interval indicators, by which the patient may locate her own fertile periods under my supervision. The procedure has been used in some instances to avoid pregnancy; in others to bring about pregnancy; and in many to space pregnancies properly.

Of these 500 women, 20 were considered unfit to apply the fertile period knowledge.

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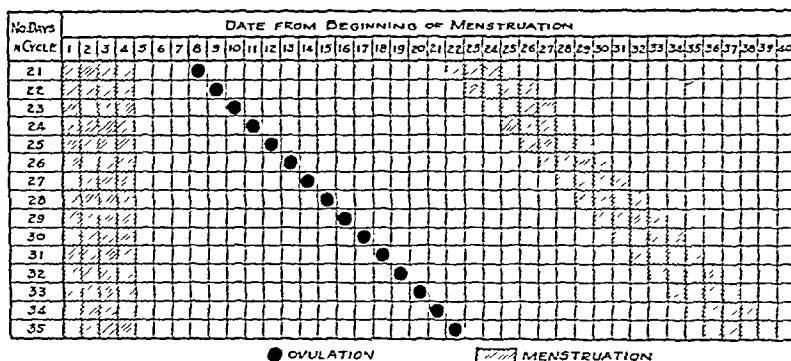


Fig 1 Ovulation date for various cycles

the day of ovulation in various cycles ranging from 21 to 35 days in length. In all of my work I have used a 5 day fertile period for a given cycle. This includes the day of ovulation as the fertility period of the egg cell, and 2 days preceding the day of ovulation as the fertilizing life span of the sperm cell. A day is then added at the beginning and end of this 3 day period to allow for the variation of a fraction of a day in the actual time of ovulation. The fertile periods for a number of cycles are shown in Figure 2, the day of ovulation being the next to the last day of the fertile period in each case.

In the present state of our knowledge the only exact measure of the length of the menstrual cycle is its termination, the onset of the next menstruation, and the beginning of the next cycle. If it were necessary to wait for this occurrence the information would be just 2 weeks late, and the only woman who could apply the fertile period knowledge would be one with the uniform cycle, having the same number of days each month. Such women are apparently very rare indeed.

THE LAW OF CYCLE VARIATION

Accurate study of the menstrual cycles of many women has revealed, however, that there is a law of recurrence in their cycles. This law may be expressed as follows: *Barring accident or disease, the menstrual cycle of a normal woman varies in length continually between a certain maximum and minimum number of days.* Here is the key that opens the door to the location of the ovulation date

within a certain period, thus pointing out the location of a period of possible fertility in the cycle of a normal woman.

The longest and shortest cycles shown by the written record, kept for 6 months or more, determine the length of the period of possible fertility. For instance, if the shortest cycle is 26 days and the longest cycle is 30 days, ovulation may occur on the thirteenth, fourteenth, fifteenth, sixteenth, or seventeenth day of the cycle, as shown in Figure 1. Allowing 3 days before the first ovulation date and 1 day after the last ovulation date, the period of possible fertility is from the tenth to the eighteenth day, inclusive. All the remaining days of the cycle are sterile. Figure 3 shows the periods in the 26 to 30 day cycle graphically.

NORMAL CYCLE LENGTH AND VARIATION

In the 480 normal patients who form the basis of this study the first thing of interest is the cycle length and its variation. Table II shows that these women had individual cycle variations of from 1 to 9 days. The numbers of cases for each variation follow the "normal distribution" type of curve, as would be expected, the variation norm probably lying between 4 and 6 days. The rarity of the uniform, unvarying cycle, as well as the variation of 10 days or more, is definitely indicated. The fact that about 85 per cent of these women had a variation of not more than 6 days (11 day fertile period) is also of interest.

The lower limits of the cycle lengths are listed in Table III. It will be noted here that

TABLE I—LOCATION OF OVULATION BY SYMPTOMS

Previous menstruation	Ovulation symptoms		Following menstruation at on	Interval—days	Length of cycle—days
	Location	Date			
12-1-15	Right ovary	Dec 14	Dec 29	14	37
12-18-25	Left ovary	Jan 13	Jan 27	14	30
1-27-36	Both ovaries More on right	Feb 13	Feb 27	14	31
2-27-36	Left ovary	Mar 16	Mar 30	14	31
3-10-36	Right ovary	Apr 24	Apr 8	14	29
4-18-36	Left ovary	May 14	May 28	14	30
5-26-36	Right ovary	June 11	June 25	14	28
6-25-36	Left ovary	July 8	July 22	14	27
7-22-36	Both ovaries More on right	Aug 7	Aug 21	14	30
8-21-36	Left ovary	Sept 7	Sept 21	14	31
9-21-36	Right ovary	Oct 9	Oct 23	14	32
10-23-36	Left ovary	Nov 7	Nov 21	14	29
11-21-36	Right ovary	Dec 8	Dec 22	14	3

their condition being determined by a simple procedure which is followed in each case (1) each woman is required to present a written record of the beginning dates of the last six menstruations, (2) each woman is given a thorough physical examination which includes a pelvic search for pathology

IMPORTANCE OF PHYSICAL EXAMINATION

The physical examination is just as important as the menstrual record, because a woman may have a seemingly normal cycle variation and yet be afflicted with some systemic or pelvic condition which will soon make it impossible for her to use the fertile period law successfully. This careful weeding out of the abnormal cases accounts in a large measure for the very gratifying results obtained in this study as compared with the many failures reported by other women who have attempted to apply the new knowledge without the advice and guidance of their physicians.

The 20 abnormal women showed the following conditions: 3 had well advanced pulmonary tuberculosis, 4 had a fibroid uterus, 1 had an ovarian carcinoma, 4 had cervical carcinoma, 2 had occluded fallopian tubes, 4 had large ovarian cysts, 1 had a uterine polyp, and 1 had pernicious anemia.

PHYSIOLOGICAL FACTS LOCATE FERTILE PERIOD

The existence of definite fertile and sterile periods in the menstrual cycle is based on just three facts: (1) Ovulation occurs 14 days before the following menstruation. (2) The egg cell can be fertilized only during the 12 hour period immediately following its emergence from the follicle. (3) The fertilizing ability of the sperm cell in the female genital tract is maintained for not more than 24 to 36 hours.

Much research remains to be done to determine these intervals exactly under all kinds of conditions. For example, no free fertilized human egg has ever been removed from the uterus of a woman, the youngest embryo yet described being 11 days old.

However, if the intervals herein noted are assumed to be the maximum, it is possible to calculate the location of supposedly sterile periods, which can then be tested for various cycles. This has been the basis of my 5 year study.

OVULATION INDICATED BY SYMPTOMS IN SOME CASES

Many women observe a painful sensation over one or both ovaries for an hour or more at the time of ovulation. Late in 1935 I asked one of my patients who always recognizes the *mittelschmerz* to keep a record of the date and location of these pains, as well as the menstruation dates. Her record is shown in Table I. This woman is in normal health, 32 years old, and has two children. She knows nothing about the time when ovulation is supposed to occur. She describes her symptoms on the dates shown as similar to those at the onset of menstruation. The record is valuable as corroborating evidence that ovulation occurs 14 days before the following menstruation. We have found, however, that most women cannot locate the day of ovulation accurately from symptoms.

FERTILE PERIOD LOCATED BY OVULATION

For the location of the fertile period the day of ovulation is the basis. As already stated, ovulation occurs 14 days before the following menstruation. Figure 1 shows the position of

Research along this line is now being conducted in this clinic.

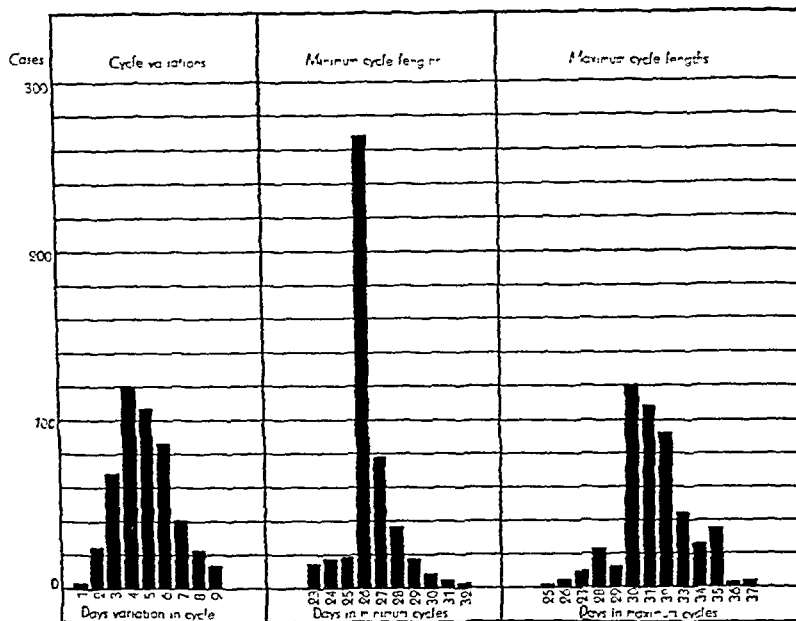


Fig. 4. Graphic presentation of Tables II, III, and IV

period, although 7 of them used contraceptive methods. It is, of course, impossible for a doctor to enforce continence during the fertile period, but in all cases in which the patient's health had depended on the avoidance of pregnancy I have instructed them carefully and no failures have resulted.

During this study 27 women have used the fertile period procedure to space their pregnancies properly. In other words, they first avoided pregnancy and later conceived at the desired time through cohabitation during the fertile period. Fifteen women came seeking advice for the relief of sterility of one or more years' standing, and for the sole purpose of becoming pregnant. Six of them became pregnant after a single cohabitation during the fertile period. Two of the 6 afterward avoided conception for several months and then attained a second desired pregnancy through a single cohabitation during the fertile period. They are now using the procedure to avoid further conception.

RELIEF OF SUPPOSED STERILITY

The case of Mrs. G. H., age 32, married 8 years, is a good example of the relief of supposed sterility (Fig. 5).

She came to us complaining of sterility, but examination showed no essential reason why she could not become pregnant. Her menstruation record for 6 months revealed a 27 to 32 day cycle, the last menstruation date being July 26. During the month of August she cohabited just once, on August 13. No menstruation having occurred on August 30, a rabbit test for pregnancy was made and showed positive. In 280 days from the beginning of the last menstrual period she gave birth to a 9½ pound baby girl. Menstruation again occurred 4½ months after delivery and the menstrual record for the next

TABLE II.—CYCLE VARIATIONS OF 480 NORMAL WOMEN

Cycle variation in days	Number of cases	Per cent of cases	Cumulative percentage
1	2	0.4	0.4
2	24	5.0	5.4
3	68	14.2	19.6
4	120	25.0	44.6
5	106	22.2	66.8
6	85	17.7	84.5
7	40	8.3	92.8
8	22	4.5	97.3
9	13	2.7	100.0
	480	100.0	

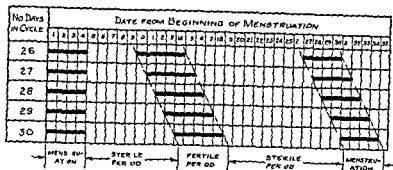


Fig 2 Fertile period for various cycles

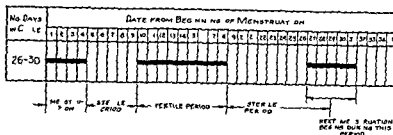


Fig 3 Various periods, in 26 to 30 day cycles

the numbers of cases do not follow the "normal distribution" curve since a majority of these women had a minimum cycle length of 26 days

Table IV lists the maximum cycle lengths. Here the numbers of cases again seem to follow the normal distribution with the maximum cycle length normally lying between 30 and 32 days. The data listed in Tables II, III, and IV are shown graphically in Figure 4 which gives a fairly definite picture of what the physician can expect among his normal healthy patients. It shows that the old, time honored 28 day cycle has been largely a figment of the imagination and that the average healthy woman will have a cycle which varies between a minimum of 26 or 27 days and a maximum of 30 to 32 days.

The implications of these figures are extremely fascinating because they point to the possibility of using the accurate record as an indicator of abnormal female condition. I have explored this possibility and in a number of cases have been able through careful study of the menstrual record and a subsequent examination, to detect incipient disorders of which the patients were entirely unaware.

IMPORTANCE OF MENSTRUAL RECORD IN DIAGNOSIS

It is my belief that an accurate menstrual record is a definite indicator of normal or abnormal function and that a more concerted effort should be made by members of the medical profession to secure accurate, authentic menstrual histories. Heretofore most of the published records have come from the inmates of hospitals and other institutions and were based entirely on memory. Little attention has been paid to the physiological and pathological conditions of the women in relation to the menstrual flow. What we need is a great mass of data from women in all walks of life, from the normal, healthy ones, as well as those who suffer from incipient or advanced abnormal conditions.

CONCEPTION CONTROLLED SUCCESSFULLY

A most significant fact about this 5 year use of the fertile period procedure is that not a single pregnancy has resulted from cohabitation outside the fertile periods established for the various patients. A total of 12 women who desired to avoid pregnancy have become pregnant through cohabitation during the fertile

		FIVE - YEAR COHABITATION RECORD																														28 TO 33 DAY CYCLE					
YEAR	DATE WEEKS BEGAN	NUMBER OF DAYS FROM BEGINNING OF MENSTRUATION																																	No DAYS IN CYCLE		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
1930	DEC 31									X														X	X	X	X	X							30		
	JAN 30					3 1/2				X				X	X	X								X	X												
		3 1/2					PREGNANT - ABORTED MAR 24TH												X	X																	
	APR 27	7 1/2					X	X	X														X			X	X	X								29	
1931	MAY 26	7 1/2	A 1/2					X	X	X					X													X	PREGNANT - ABORTED JUNE 1								32 1/2
	JUL 24				X	X	X																		X		X									31	
	AUG 28					X			X	X																X	X	X								32	
	SEP 29					X		X	X	X																X	X	X	X							33	
	NOV 1				X			X																			X	X	X	X						31	
	DEC 2					X			X	X															X	X		X		X						32	
	JAN 2					X			X																	X	X	X	X							30	
	FEB 3				X			X	X	X																X	X	X	X	X						33	
	MAR 5					X		X	X	X															X	X										32	
	APR 7					X	X	X	X	X																X	X	X	X	X						28	
	MAY 9				X			X	X	X																X	X	X								28	
1932	JUN 4					X	X		X	X																X	X	X	X							30	
	JUL 4					X	X	X	X	X																X	X	X	X							28	
	AUG 1					X	X	X	X	X																X	X	X	X							29	
	AUG 31					X	X	X	X	X																X	X	X	X							31	
	SEP 29				X			X	X	X																X	X	X	X							30	
	OCT 30							X																		X			X							30	
	NOV 29				X		X	X	X	X																X	X	X	X							31	
	DEC 30					X		X		X																	X	X								30	
	JAN 29					X		X	X	X																	X	X	X	X						28	
	FEB 24				X			X	X	X																X	X	X								31	
1933	MAR 21					X		X		X																X	X	X								29	
	APR 27					X	X	X																			X	X	X							29	
	MAY 28					X	X	X																		X	X	X								28	
	JUN 24				X			X	X	X																X	X	X	X							29	
	JUL 21				X	X	X	X	X	X																X	X	X	X							32	
	AUG 22					X	X	X	X	X																X	X	X	X							33	
	SEP 23				X	X	X	X	X	X																X	X	X	X	X						33	
	OCT 24				X	X	X	X	X	X																X	X	X	X	X						33	
	NOV 28				X	X	X	X	X	X																X	X	X	X							29	
	DEC 27				X				X	X																X	X	X								29	
	JAN 25					X		X	X	X																X	X	X	X							28	
	FEB 22					X		X	X	X																X	X	X	X							29	
	MAR 23					X		X	X	X																X	X	X	X							28	
	APR 24					X	X	X	X	X																X	X	X	X							29	
1934	MAY 19					X	X																			X	X	X	X							31	
	JUN 19					X	X		X	X																X	X	X	X	X						33	
	JUL 22					X	X	X	X	X																X	X	X	X							28	
	AUG 19					X	X	X	X	X																X	X	X	X	X						30	
	SEP 18					X	X	X	X	X																X	X	X	X	X						29	
	OCT 17					X	X	X	X	X																X	X	X	X	X						29	
	NOV 15					X	X	X	X	X																X	X	X	X							31	
	DEC 16					X	X	X	X	X																X	X	X	X							28	
	JAN 13					X	X	X	X	X																X	X	X	X							28	
	FEB 10					X	X	X	X	X																X	X	X	X							27	
	MAR 9					X	X	X	X	X																X	X	X	X							29	
	APR 7					X	X	X	X	X																X	X	X	X	X						29	
1935	MAY 4					X	X	X	X	X																X	X	X	X	X						29	
	JUN 4				X	X	X	X	X	X																X	X	X	X							31	
	JUL 5				X	X	X	X	X	X																X	X	X	X							33	
	AUG 7				X		X	X	X	X																X	X	X	X							28	
	SEP 4					X	X	X	X	X																X	X	X	X	X						32	
	OCT 6					X	X	X	X	X																X	X	X	X	X						32	
	NOV 7					X	X	X	X	X																X	X	X	X	X							
	DEC 8																																				
		STERILE PERIOD										PERIOD OF POSSIBLE FERTILITY 28-33 DAY CYCLE										STERILE PERIOD															
/////// - FERTILE PERIOD FOR GIVEN CYCLE. X - COHABITATION DATES. O - OVULATION DATES. A - ABORTION DATES																																					

Fig. 6 Five year cohabitation record

Mrs F G, aged 35 years, married at the age of 20, had 3 children, the youngest aged 10 and an incurable idiot. Because of the great burden her youngest child has been to her family she did not desire more children for fear that they too might be feeble minded. In spite of the fact that she earnestly sought contraceptive advice and had used various types of vaginal suppositories, jellies, and cones;

also a combination of jellies and rubber diaphragms; a gold stem pessary; also lemon juice lysol, potassium permanganate, boiled milk and iodine as douches, nevertheless, during the following years she became pregnant six times and underwent six self-induced abortions. Having heard of the fertile period theory she came with an 8 months' record of her menstruation dates and volunteered the infor-

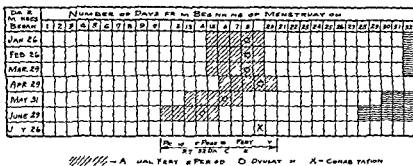


Fig. 5. Relief of supposed sterility

6 months revealed a 28 to 32 day cycle. For the next 11 months she avoided pregnancy and, during the twelfth month a single cohabitation during the fertile period resulted in a desired pregnancy. She gave birth to a 10 pound boy, 281 days after the beginning of the last menstruation. Four months later menstruation again commenced and a 6 month record showed a 28 to 31 day cycle. She is now using the fertile period procedure to avoid further conception.

A 5 YEAR COHABITATION RECORD

I am fortunate in being able to present the cohabitation record of Mrs. E. J., who has been noting the dates of her cohabitations and menstruations since 1931.

This woman first attempted to utilize the fertile period law after reading a lay book on the subject and became pregnant twice. She was later instructed by me and has avoided pregnancy for several years. The cycle variation has been from 28 to 33 days and the location of the various cohabitations with respect

to the period of possible fertility, the actual fertile periods and the ovulation dates is shown in Figure 6. It is interesting to note that although the first day of the possible fertile period was violated in 5 instances during 1932 and 1933 no conception resulted.

TIME INTERVALS AMPLE AND PRACTICAL

That the time allotted for the life of the sperm cell and the fertility period of the egg cell is ample there can be no doubt, because many women have reported violations of the first and last days of the period of possible fertility. Still no pregnancy resulted and a careful examination of their records show that they missed the actual fertile period for the current cycle by only one day. A case in point is reported in brief as follows:

TABLE IV—MAXIMUM CYCLE LENGTHS OF 480 NORMAL WOMEN

Maximum cycle in days	Number of cases	Per cent of case
25	1	2
26	4	8
27	9	19
28	23	48
29	3	25
30	110	24.8
31	1	25.1
32	91	19.0
33	44	9.2
34	5	5
35	35	7.3
36	8	4
37	4	8
	480	100.0

TABLE III—MINIMUM CYCLE LENGTHS OF 480 NORMAL WOMEN

Minimum cycle in days	Number of case	Per cent of cases
23	14	8
24	16	3.3
25	18	3.7
26	200	50.1
27	77	16.0
28	50	11.7
29	17	3.5
30	8	1.7
31	5	6
32	2	5
	480	100.0

nostic aid of abnormal female sex organ function. It also shows that ovulation has a definite time relationship to the next succeeding menstruation, and indicates that the time between ovulation and the next menstruation is a matter of 14 days.

1. The regularity, duration, and character of the menstrual periods are the chief signs indicating normal or abnormal female sex organ function.

2. Barring accident or disease the menstrual cycle of a normal woman varies continually between a certain maximum and minimum number of days.

3. Ovulation has a definite time relationship to the next succeeding menstruation and, regardless of the rhythm in the menstrual cycle, this relationship does not change.

4. That there are definite periods of physiological fertility and sterility in the menstrual cycles of normal women appears to be a definitely established biological law.

5. The fundamental scientific basis of the fertile period procedure is sound and reliable. The procedure offers to mankind, when it is supervised by a physician, a simple, dependable, and physiological method for conception control.

mation that her cycle was exactly 26 days. A careful check showed it to have a 24 to 26 day variation. A suitable calendar was furnished to her with specific instruction for its use. A year later she returned with the calendar properly marked to show menstruation dates and cohabitations. This time she informed me that the device had certainly been a God send to her that she had had 66 cohabitations and had not become pregnant. Careful study of the calendar revealed some startling facts which nevertheless show that there is a considerable safety factor in the time intervals used. She had coitus five times on the first day of the possible fertile period, five times on the last day of the possible fertile period, and three times she violated both the first and last days of the same period. Still no pregnancy resulted because she missed the actual fertile period by exactly one day in each instance.

TEDIOUS CALCULATIONS ELIMINATED

For most doctors and their patients calculations of the various periods are tedious and subject to error. Fortunately, accurate charts have been published giving the required information instantly when the cycle has been determined from the patient's written record.

In my practice I use a chart which shows the fertile periods, the sterile periods, and the time of ovulation for about 90 different cycle variations. It also indicates, by means of an accessory aid, the actual calendar dates in any period and the number of days between any two consecutive menstruation dates. This chart is very much worth while because it obviates counting on the calendar, saves time and eliminates the chance of error.

TIME INDICATORS FOR PATIENT'S USE

The last necessity for the doctor who utilizes the fertile period procedure for his patients is a means for getting the information to them in some usable form which will eliminate as far as possible the chances of error on their part. There are available a variety of indicating devices and many lay books have been published on the subject. The lay books are all very interesting to read, but our experience has been that most women are not able to apply the published information in a practical manner, their calculations being about 90 per cent wrong.

During this 5 year study 7 different styles of indicating devices or individual calendars have been investigated. Although elaborately

constructed, one was applicable only to women with a cycle variation of 26 to 31 days. Three others were discarded as being much too complicated, even for most physicians. A fifth one was found to locate ovulation 15 days before the following menstruation, and investigation showed that 5 pregnancies had resulted from coitus on the first indicated non fertile day after ovulation. A sixth was found to be thoroughly reliable, but indicated what seemed to us an unusually long fertile period. The seventh is now being generally used by our patients. It is made up to suit any one cycle variation only, incorporates a standard continuous calendar, and is therefore less liable to error. Unlike all others, it is distributed only through the medical profession. During the past 3 years it has had no recorded failures in more than 30,000 cohabitations.

PRACTICAL AND SIMPLE ROUTINE PROCEDURE

Beyond these indicating devices the doctor needs no further equipment to put the fertile period procedure into practice. In this clinic every menstruating woman is told of the importance of an accurate menstrual record and is given a suitable card on which to record the dates. Every recently confined woman is instructed as to the importance of spacing pregnancies. A regular, completely effective routine has been developed, in which there are only four comparatively simple steps.

1. Get from the patient a list written down at the time of the last 6 or 8 menstruation dates.
2. Determine the cycle variation from the longest and shortest cycles in the list.
3. Examine the patient for abnormal pelvic conditions and correct those found, if necessary.
4. Furnish to the patient an indicator or individual calendar that is as nearly fool proof as possible.

SUMMARY AND CONCLUSIONS

A 5 year clinical study of the fertile and sterile periods of women has been made. This study quite definitely points out the value of accurate menstrual records as an early diag-

lier papers on the subject reported that corpus luteum extracts failed to inhibit ovulation in rodents. The present view universally held by all students of the subject, however, is that corpus luteum is directly concerned with the course of pregnancy. Corner (12) sums up the matter in this way: Broadly speaking, the endocrine function of the corpus luteum is a part of the mechanism of pregnancy. Its action is exerted on the uterus to prepare that organ for the reception and nutriment of the embryo. When the ovum begins its journey through the fallopian tubes, the follicle whence it took its origin gives place to the corpus luteum, and this newly formed corpus luteum begins to deliver into the blood stream a substance causing extensive development of the uterine glands and changing the histological structure of the uterine mucosa or endometrium. By the time the fertilized ovum reaches the uterus, the endometrium through this action upon it of corpus luteum hormone is in a state of heightened secretory activity by which nutritive substances are provided for the embryo. Furthermore, through the action of the corpus luteum secretion, the endometrium is sensitized so that it responds to the presence of the embryo by forming the maternal part of the placenta. It has been shown experimentally that removal of corpus luteum from an animal during the early part of pregnancy results in failure to implant the embryo or, if the embryo is already implanted, effects a deterioration of the pregnancy. Corner found that injection of corpus luteum extract in castrated rabbits produced pregnancy changes in the uterus. In rabbits castrated during early pregnancy, injection of progestin protected the embryos against the loss of their mothers' corpora lutea and maintained the pregnancy to full term. In guinea pigs progestin was found to sensitize the uterus to produce the maternal placenta or so called Loeb's *deciduoma*.

2. RELATION OF CORPUS LUTEUM TO MENSTRUATION

It is now generally known that menstruation is not identical with ovulation although it bears a definite relation to the estrus cycle of various animals, including human beings.

Physiologically speaking, menstruation is the last effort made in the sex cycle of higher animals after there has been failure to conceive. It has been shown in women (100) and in monkeys (80) that menstruation, disappearing as a result of ovariectomy, may be induced experimentally by treatment with estrogenic substances. On the other hand, Pratt claims that excision of corpora lutea in adult primates will precipitate menstruation. It has been demonstrated that the injections of corpus luteum extract may delay or postpone menstrual periods experimentally produced in monkeys. It is now generally agreed that, in the normal menstrual cycle, both the estrogenic or follicular hormone and corpus luteum play rôles. Typical progestatized endometrium has been produced in ovariectomized monkeys by successive folliculin and corpus luteum injections (35). Similar experiments have been reported by Smith and Engle (89), and Kaufmann has actually produced premenstrual endometrium in castrated women by first administering large doses of estrogenic substance to bring the uterus back to its normal interval stage and then injecting corpus luteum extract to effect the premenstrual changes. A proper balance between the follicular and corpus luteum hormones is essential for normal menstruation, as estrogenic substance has been demonstrated in the human corpus luteum during the premenstrual stage (2, 4). These studies on menstruation point unequivocally to an important endocrinological function of the corpus luteum in primates but the methods employed are too complicated for practical routine assay of the hormone.

3. HISTOLOGICAL CHANGES INDUCED BY CORPUS LUTEUM EXTRACTS

Various investigators have found that progestin or corpus luteum hormone produces histological changes in different lower animals and also in human beings. Corner states that administration of progestin produces pregnancy changes in uterus of castrated rabbits. Corpus luteum extracts, administered to rabbits castrated during early pregnancy, as has already been stated, protect the embryos against loss of the mothers' corpora lutea and

METHODS OF DEMONSTRATING THE ACTIVITY OF CORPUS LUTEUM

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THE exact number of ovarian hormones present in the body of higher animals is still in dispute. Many think there are at least three such internal secretions—the follicular hormone, the corpus luteum hormone, and the hormone of interstitial tissue, others, a larger number. Fraenkel's early researches stressed corpus luteum as the most important internal secretion of the ovary, a view which prevailed for some years although slightly modified by Marshall and others. Later, studies on the effect of x rays on the female gonads brought the function of the so called interstitial ovarian tissue into prominence and pointed to the endocrinological action of that tissue, elucidated by the work of Bounin, Ancel and Villemin, and of Steinach and Holzkehn. Following the interesting researches of Stockard and Papanicolaou (93) concerning the histological changes in the gonads and accessory organs produced at various periods of the estrus cycle, an enormous amount of work was done on the cellular structure of the vaginal epithelium which culminated in the study of the estrogenic or follicular hormone by means of vaginal smears. These researches, popularized by the writings of Allen and Doisy (3), S. Loewe, and others directed the attention of physiologists to the function of the follicular fluid and stressed the hormones contained therein as the principal endocrine product of the ovary. While the exact number of ovarian hormones is still unsettled and their chemical nature occasions even more dispute among those investigators who have been working on the biochemistry of the gonads, it is the general consensus that the female gonad elaborates at least two different hormones quite distinct in their physiological function. One of these is the follicular hormone, often known by other names such as estrogen, folliculin, amniotin, menformon etc., the other is an internal secretion elaborated by corpus lu-

teum particularly when fully developed. The physiological action of the follicular hormone can be demonstrated in several ways and especially by the study of the vaginal epithelium obtained from smears or scrapings of castrated female rats, mice, and guinea pigs. The character of the cells thus obtained changes after such castrated animals have been injected with estrogenic hormone. Demonstration of the physiological function of corpus luteum, although effected in any one of a number of ways, is much more difficult. The purpose of the writer is to offer a brief resumé of the physiological procedures employed for detecting and demonstrating the activity of corpus luteum either *in vivo* or by pharmacological use of corpus luteum extracts and further more to describe and present his experiences with some of the newer methods of approach more recently employed in that connection.

Experimental data pointing to physiological action of corpus luteum hormones may be classified as those pertaining to (1) the relation of corpus luteum to pregnancy, (2) the relation of corpus luteum to menstrual cycle of monkeys and human beings, (3) histological changes produced by corpus luteum in sexual apparatus, (4) changes effected by corpus luteum in vaginal epithelium, (5) gross anatomical changes produced by corpus luteum hormone in uterus etc., (6) influence of corpus luteum on contractions of smooth muscle, and (7) miscellaneous physiological effects produced by corpus luteum.

I. RELATION OF CORPUS LUTEUM TO PREGNANCY

Pearl and Surface have described an inhibition of ovulation following intraperitoneal administration of a fat free preparation of corpus luteum substance. Haberlandt, Knaus (47) and Kennedy noted that temporary sterility of females was produced by injections of corpus luteum extracts. On the other hand, Loeb, and Corner and Hurns (14) in their ear-

the results of which indicate that such corpus luteum injections, as compared with those of the follicular hormone, exert an antagonistic action. The experiments were made on various series of guinea pigs. For a long time the normal cycle of each animal was determined by vaginal smears. After the duration of the respective animals' estrus cycles had been established, guinea pigs were given repeated daily injections of water-soluble corpus luteum extracts (prepared by various methods); and their effect on the duration of the cycle was observed. It was found that the corpus luteum injections markedly prolonged the *diestrus* or interestrus interval. Table I reveals the findings obtained in experiments with 27 such animals. While the average diestrus of normal or untreated animals was 11.9 days, that of the guinea pigs thus treated with corpus luteum extracts was 44.7 days. These figures demonstrate decisively that corpus luteum greatly prolonged the interestrus interval. Of further interest was a supplementary study made by Macht and Stickels (62) in which corpus luteum was not injected but fed to guinea pigs for long periods. Table II shows the results obtained in these tests.

5. CHANGES IN GROSS ANATOMY

Besides the histological or microscopic changes produced by female sex hormones injected under specified conditions, marked changes in the *gross* appearance of various organs have also been observed after such treatment. Indeed, the most important criterion of the activity of extracts used in earlier work on this subject was the gross appearance of the uterus and gonads. Many such changes were noted after injection of follicular extracts in one form or other. The aim of some of the early injection experiments was to "maintain uterine nutrition," inasmuch as removal of both ovaries was invariably followed by atrophy of the uterus. Such administration of some of the extracts was followed by most striking results (1, 11, 22, 24, 31, 38, 39, 71, 83, 84, 85). Another criterion was the *swelling* and *hyperemia* produced by ovarian extracts in area surrounding the external genitalia of rabbits, pigs, dogs, and monkeys (91). Changes in size of the uterus in the smaller rodents were

TABLE I—EFFECT OF INJECTIONS OF CORPUS LUTEUM ON ESTRUS CYCLE OF THE GUINEA PIG

Guinea pig number	Days of normal interestrus	Days of interestrus after injections of corpus luteum
1	13	29
2	12	25
3	12	22
4	12	64
5	14	48
6	13	59
7	12	42
8	13	30
9	13	30
10	13	16
11	14	14
12	13	39
13	12	47
14	14	29
15	10	30
16	9	22
17	9	30
18	15	33
19	9	20
20	9	22
21	9	22
22	10	23
23	15	30
24	9	22
25	15	41
26	11	33
27	12	36
Average	11.9	44.7

of special interest. Zondek and Aschheim (102) noted an increase in size of uterus of mice injected with follicular extracts. Similar observations were made by Kochmann. Other changes were noted in the mammary glands (7, 55) of both males and females but especially of the latter. Frank and Rosenbloom noted that certain ovarian extracts injected in rabbits stimulated the growth of not only the uterus but also the vagina, breasts, and accessory organs, while Courrier observed that they accelerated development of the uterus and other genitalia in newly born animals. After continued treatment of rats with

induce characteristic pregnancy changes in the uterus, and corpus luteum hormone administered to guinea pigs, sensitizes the uterus and produces the maternal placenta or so called Loeb's *deciduoma*. Later work by Hisaw, Meyer and Fevold, by Smith and Engle, and by Corner revealed that progesterin, administered to monkeys, produces a picture characteristic of premenstrual endometrium. So characteristic is the change produced by progesterin in rabbits according to Corner and Allen (13), that they have advocated as a standard for assaying it the so called *rabbit unit*, which is the amount of the hormone (divided into 5 equal daily doses) that will produce on the sixth day a microscopic condition of the uterus equal to that of the eighth day of normal pregnancy. Injections of corpus luteum hormone have also produced physiological changes in other and more remote organs.

Herrmann and Stein (32) reported that when injected in young male rats and rabbits, the estrogenic hormone delayed attainment of sexual maturity and furthermore that large quantities of corpus luteum hormone injected in adult rats and rabbits, produced in the testes degenerative changes not unlike those produced by x rays. Fellner (20, 21) repeated and extended this work and discovered that degeneration of testes was produced by injections of placental or corpus luteum lipoids. This so called "antimale" property of corpus luteum is of interest in connection with the peculiar reaction of the vas deferens and seminal vesicles described by Macht and Matsumoto. The latest study on histological changes is that made by Pincus and Werthessen, who have correlated the activity of corpus luteum preparations with microscopic measurements of the actual size of the ovum. All such studies as those mentioned, however require very complicated technique and are not suitable for practical bioassay of corpus luteum preparations. One special method of histological character however, is adapted to the assay of estrogenic substances and has been employed by the present writer also in testing corpus luteum extracts and preparations. It is the study of the vaginal epithelium.

4 EFFECT OF CORPUS LUTEUM HORMONE ON VAGINAL EPITHELIUM

The most popular method for studying female hormones, derived from the follicles and spoken of as the follicular or estrogenic hormones or theelin may be described as follows. Vaginal smears obtained from normal intact rats or mice present periodic variations in the number and character of epithelial blood, and other cells in relation to their estrus cycles. In castrated or ovariectomized animals a typical and constant picture of the diestral stage is maintained. When injections of estrogenic hormone are given to such animals however, the character of the vaginal cells changes and repeated injections produce a picture of estrus. Accordingly use has been made of such changes in vaginal cells in assaying preparations of that type.

Can any change in character of the cells obtained from vaginal smears be effected by administration of corpus luteum hormone? Corpus luteum in contrast to estrogenic substance, can obviously not be expected to stimulate estrus. On the other hand, there is a possibility of its acting synergistically or antagonistically to follicular hormone. A number of investigators have attacked this problem. The most satisfactory experiments with corpus luteum on the estrus cycle of animals were obtained not with mice or rats (because of the short duration of their cycles) but with guinea pigs, the estrus cycle of which is considerably longer (10 to 12 days). Thus, Papanicolaou, who injected extracts from the corpus luteum in guinea pigs reported inhibition of estrus, determined by the smear method over extended periods while negative results were obtained in control tests on follicular fluid, placenta and other tissue. Papanicolaou considers this the proper luteal hormone. Parkes and Belferby obtained vaginal reactions in mice by injecting small doses of follicular fluid after ovariectomy and attributed such results to removal of corpus luteum inhibition. Voss has also effected an inhibition in guinea pigs by administering corpus luteum extracts.

The present writer in collaboration with Stickels and Seckinger (65) has for several years carried on studies along these lines,

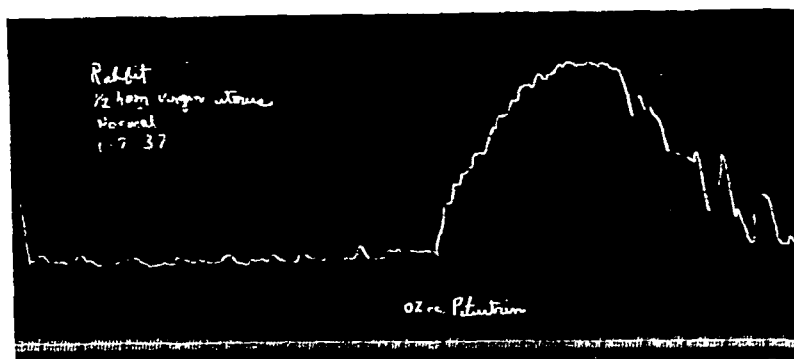


Fig 1. Stimulation of uterus of virgin rabbit effected by 0.02 cubic centimeter of pituitrin (surgical, P D).

6. RELATION OF FEMALE GONADS TO ACTIVITY OF UTERINE AND OTHER SMOOTH MUSCLE ORGANS

A. Relation to posterior pituitary hormone

In recent years studies on the contractions and tonicity of the smooth muscle from the uterus, fallopian tubes, seminal vesicles, vasa deferentia, etc., have thrown considerable light on the intricate physiology of the sex hormones and yielded useful criteria for evaluating their activity, particularly that of the corpus luteum. Knaus (48, 49, 50) established the fact that the excised uterus of a rabbit under the influence of a functioning corpus luteum did not respond to treatment with the posterior pituitary hormone *in vitro* as did the

virgin uterus, whereas even minute doses of pituitrin effected a powerful contraction in the control, taken from a virgin rabbit.

While it is generally accepted that the estrogenic hormone stimulates the contractions of the uterus, as shown by the work of Parkes, Kelly, Zondek and Aschheim (103), Brouha, and others, accumulated evidence reveals that in normal higher animals and the human being, the corpus luteum hormone inhibits or quiets contractions of the uterus. Thus Knaus (51) and Manzi maintain that the uterus is kept in a state of quiescence during pregnancy by the influence of the corpus luteum and when, toward the end of pregnancy that effect diminishes, the organ becomes more

TABLE III—EFFECT OF INJECTIONS OF ESTRIN ALONE AND ESTRIN PLUS LUTEIN ON WEIGHT OF MOUSE UTERUS

Mouse number	Estrin alone, 0.2 c.cm. daily			Estrin, 0.2 c.cm., plus lutein, 0.5 c.cm., daily		
	Weight of body in milligrams	Weight of uterus in milligrams	Ratio of uterus to body weight	Weight of body in milligrams	Weight of uterus in milligrams	Ratio of uterus to body weight
1	20,000	50	400	22,700	25	908
2	22,200	50	444	19,500	20	975
3	25,800	65	397	24,700	45	549
4	27,200	70	389	19,000	20	950
5	22,000	170	120	27,200	85	320
6	20,150	55	366	16,800	30	560
7	20,840	55	379	21,450	30	715
8	20,550	55	374	20,950	30	698
9	25,500	125	204	23,400	45	520
10	22,500	110	205	21,550	50	539
	Average		282	Average		587

TABLE II—EFFECT OF PROLONGED FEEDING OF CORPUS LUTEUM, ETC., ON ESTRUS CYCLE

A, animal number	Normal estrus days	Anomalies	Time animal was on progestin, in weeks	Refract days
1	7	No vary	4	8
2	9	No vary	4	9
3	8	No vary	4	9
4	10	No vary	4	10
5	11	No vary	4	11
6	8	Lutein	4	9
7	6	Lutein	4	11
8	8	Lutein	4	8
9	10	Lutein	5	15
10	7	Lutein	5	10
11	4	Lutein	5	14
12	11	Lutein	5	11
13	9	Lutein	5	1
14	6	Lutein	6	12
15	8	Lutein	6	1
16	8	Lutein	6	12
17	9	Lutein	6	13
18		Lutein	6	8
19	6	Lutein	6 and 8	15-20
20	9	Lutein	6 and 8	15-35
21	8	Lutein	6 and 8	6-18
22	8	Lutein	6 and 8	19-21
23	8	Lutein	6 and 8	25-9
24	8	Follicular C	4	3
25	9	Follicular A	4	5.5
26	8	Follicular D	4	6.5
27	8	Follicular B	4	
28	9	Follicular F	4	6
29	1	Follicular F	4	4
30	11	Follicular E	4	14
31	10	Follicular E	4	10
32	8	Follicular F	4	3

anterior lobe of the pituitary Long and Evans found that the ovaries were enlarged as the result of formation of many corpora lutea

Have any gross anatomical changes been noted after administration of corpus luteum? As late as 1927 Allen and Dowsy stated that they knew of "no successful attempts to

inhibit the action of injected follicular hormone by injection of corpus luteum extract." More recently, the present writer, collaborating with Stickels has obtained some interesting results in studies on synergistic effects of combinations of estrogen and corpus luteum hormones. This work was stimulated by the interesting finding of Siddall who developed a novel test for pregnancy. It was found that the usual ratio of the uterus weight of a mature non pregnant white mouse to its body weight is over 1.400. Normal mature mice were injected with follicular estrogenic extracts for 7 to 10 days, at the end of which period they were killed and the weight of the uterus determined. Such injections markedly increased the size of the uterus so that the ratio of its weight to that of the body fell far below 1.400.

Macht and Stickels (63) undertook similar studies with both the estrogenic hormone of the ovary and with corpus luteum extracts. A series of mice, injected daily for 2 weeks with a standard estrogenic extract, were then killed, and the ratio of the uterus weight to that of the whole body was determined. A marked hypertrophy, shown by increase in the weight of the uterus, was noted. In a second series, mice injected with corpus luteum extract alone revealed no change in size or weight of the uterus. A third series of mice was injected for the same length of time with a mixture of the same estrogenic preparation and a water soluble corpus luteum extract prepared in this laboratory. The most striking discovery made was that no hypertrophy such as had succeeded injection of estrogenic extract alone followed administration of a combination of estrogenic and corpus luteum extracts. These experiments clearly revealed that lutein antagonized or inhibited the stimulating action of the follicular hormone. Table III strikingly illustrates these findings. This antagonism between corpus luteum and follicular extracts was noted not only in injection experiments but also after feeding experiments, prolonged for several weeks in which the two hormones were administered in combination to mice. The findings in these experiments are shown in Table IV.

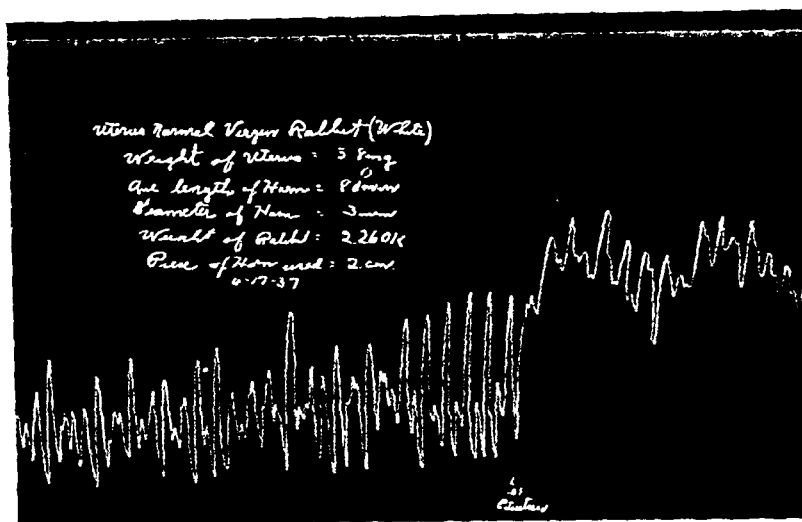


Fig. 3 Effect of 0.01 cubic centimeter of pituitrin (surgical, P D) on uterus of normal virgin rabbit

and recurrent abortion uterine contractions were inhibited by such an extract. Halban advocated the employment of corpus luteum in the treatment of abortion, and the successful use of such preparations has been reported by Glismann, Antecki and Zwolinski, Wolfson, Weinzierl, Bracht, Wagner, and Knab Krohn, Falls and Lachner employed corpus luteum for the treatment of threatened and habitual abortion and have recently (by a balloon method) demonstrated that corpus luteum inhibited the contractions of the uterus (19). More recently, Robson and Illingworth, and de Fremery, Luchs, and Tausk have studied various fractions obtained from corpus luteum extracts and found that one of these, which they called "desensin," thus inhibits the action of pituitrin on the uterus. Similar findings were made by Foster, and especially by Reynolds Corner (66) and his associates used such uterine preparations in assaying a corpus luteum hormone which they prepared and named "progestin."

The present writer has been experimenting on rabbits for over a year in order to study these remarkable variations in contractions of uterine muscle in relation to the influence of corpus luteum hormone and that of the posterior lobe of the pituitary gland. In these studies the writer employed an aqueous solu-

tion of the corpus luteum (prepared in these laboratories) of which numerous physicians have made wide clinical use with allegedly favorable therapeutic results. Healthy normal virgin rabbits were selected. In some, ovariectomy was performed, in others, the ovaries were left intact. A standard preparation of pituitrin (P D.) was used for testing the oxytocic response of uterine muscle. In most of the experiments one horn of the virgin uterus was removed under aseptic conditions and the animal was allowed to recover. The contractions with which the excised tissue in oxygenated Locke solution responded to small doses of pituitrin were carefully recorded. The rabbit operated upon was then given repeated intravenous injections of corpus luteum extract for 10 days, after which the other horn of the uterus was studied in similar fashion. It was found that injections of lutein (H W & D.) effected in behavior of the muscle such a change as that described by Corner and other previous writers. Uterine preparations (from mature rabbits) previously treated with lutein gave a much weaker response to pituitrin and, after very large doses of lutein, did not react to pituitrin at all although other oxytocic agents effected a contraction of the muscle. The subjoined curves show the type of response obtained in control animals, on

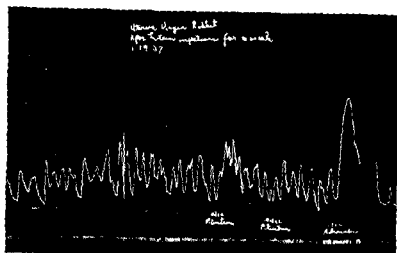


Fig. 2 Effect of repeated injections of lutein (HWD) totaling 30 cubic centimeters on uterus of virgin rabbit

sensitive to the influence of the posterior lobe of the pituitary. The work of the Smiths (90) indicates that during pregnancy a physiological balance is maintained between estrogenic and corpus luteum hormones. As pregnancy progresses the estrogenic principle, becoming more dominant sensitizes the uterus to the oxytocic influence of the posterior lobe of the pituitary, and thus labor follows. Allan and Dodds (5) expanded this theory of labor onset. Inasmuch as corpus luteum vitally affects

the normal course of pregnancy, on the one hand and inhibits the motility of the uterus, on the other numerous investigators have successfully employed extracts of corpus luteum to prevent abortion and maintain the normal course of pregnancy. Miklos prolonged pregnancy in rats with aqueous extracts of corpus luteum. Clinically Hirst injected aqueous extracts of corpus luteum from pregnant cats to prevent habitual abortion. Hofbauer reported that in threatened

TABLE IV.—EFFECT OF ESTRIN AND ESTRIN PLUS LUTFIN FEEDING ON WEIGHT OF MOUSE UTERUS

No. of subject	Estrin alone 2 to 5 mouse units daily			Estrin 2 to 5 mouse units, plus of lutein solution daily		
	Weight of body in milligrams	Weight of uterus in milligrams	Ratio of uterus to body weight	Weight of body in milligrams	Weight of uterus in milligrams	Ratio of uterus to body weight
1	21,000	5	101	18,200		124
2	27,000	20	57	24,440	40	611
3	23,000	80	330	600	5	840
4	28,200	80	352	28,370	5	855
5	3,600	60	395	17,800	0	891
6	24,700	65	380	2,370	15	85
7	87,150	70	388	24,620	40	60
8	20,520	5	380	3,580	10	74
9	15,940	15	308	15,000	5	704
10				2,500	35	808
	Average		377	Average		774

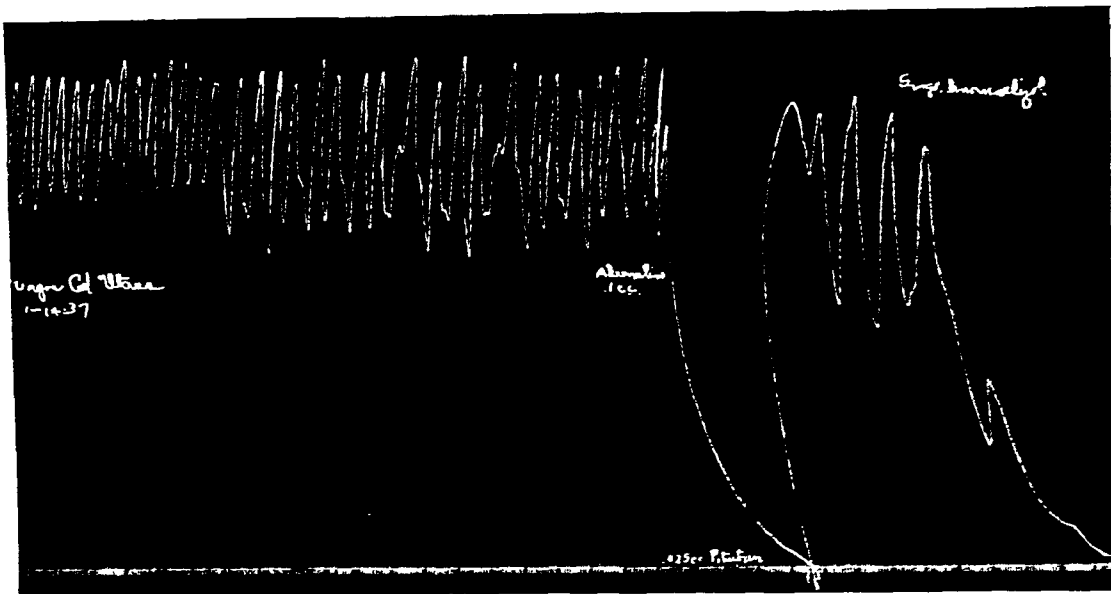


Fig 5 Relaxation of uterus of virgin cat effected by injection of 0.1 cubic centimeter of a 1:1000 solution of adrenalin, followed by stimulation produced by 0.025 cubic centimeter of pituitrin (surgical, P.D.) and, finally, by relaxation on addition of 5 milligrams of bromsalizol

alteration of character of the sex hormone set free in the cat's circulation during pregnancy. Accordingly, those authors, experimenting with injections of progestin or corpus luteum extract in cats, found that a reversal of epinephrin action took place in virgin cats under such conditions. Similar experiments were made by Kennard, and recently on guinea pigs by Holtz. The present writer, desiring to duplicate the experiments made by the American investigators, carried out a series of such studies

on virgin and pregnant animals. The results obtained fully agreed with those described. It was found that uterine preparations obtained from normal virgin cats and studied *in vitro* responded to adrenalin with relaxation of the tonus and inhibition of contractions. On the other hand, it was found that the uteri of virgin cats, injected intravenously for 2 weeks daily with extracts of corpus luteum, reacted paradoxically when treated with adrenalin and responded with much less relaxation and sometimes none at all although a positive pressor effect or contraction was noted rarely. The subjoined curves illustrate these findings (Figs 5, 6, and 7)

C. Physiological responses of the vas deferens

Some years ago Macht and Matsumoto described a third phenomenon in regard to the contractility of smooth muscle organs in relation to the sex hormones. Those findings have more significance at the present time than they conveyed 18 years ago. The authors undertook a study of the physiological effects of all kinds of glandular extracts on the motility of the genito-urinary organs or, more specifically, on the contractions of the smooth muscle they contain. The effects of various

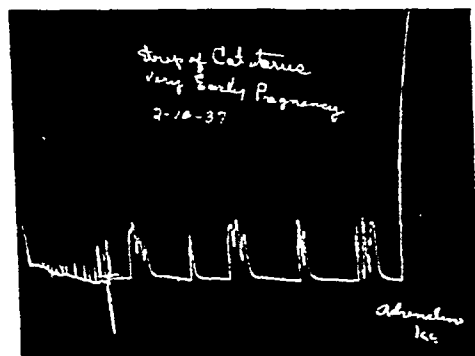


Fig 6 Stimulation adrenalin produces in uterus of cat in early pregnancy (1 to 2 weeks).

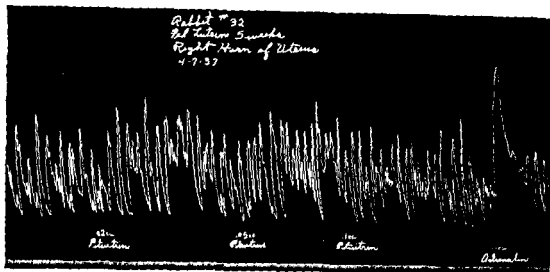


Fig. 4. Small effect produced by the administration of pituitrin (surgical P.D.) on horn of uterus of virgin rabbit which had been fed desiccated lutein (1 gm. a day) for a period of 5 weeks.

the one hand, and in rabbits treated with corpus luteum extract, on the other (Figs. 1 and 2). A comparison of the writer's curves with those of other investigators revealed that a cubic centimeter of the corpus luteum solution exerted an action similar to that effected by 0.1 milligram of progesterone.

Although, generally speaking, considerable skepticism exists regarding the effectiveness of the female sex hormone products administered *per os*, the writer is inclined to believe that the feeding of such preparations, when continued for a sufficient length of time, does have a definite physiological action. The writer has performed experiments in which instead of injecting extracts of corpus luteum, the desiccated gland was fed by stomach to rabbits for several weeks. In control experiments other rabbits were given the same food minus the powdered corpus luteum. The corpus luteum powder used in these experiments was prepared from fresh glands desiccated at low temperature. Figures 3 and 4 illustrate the results obtained with uterine muscle preparations from controls and from rabbits fed with such powder. It was found that just as injections of corpus luteum weakened the response of the muscle preparation to subsequent treatment with pituitrin or completely

suppressed it, so the continued feeding of desiccated corpus luteum rendered responses of uterine muscle from rabbits very feeble. The difference between the results obtained in the injection and feeding experiments were quantitative rather than qualitative. Of course, the feeding experiments had to be continued for a considerably longer time before the physiological effect mentioned could be obtained.

B. Relation to epinephrin. Of great physiological interest as well as of practical value is another remarkable phenomenon noted recently in studies on the rhythmic contractions of uterine muscle, i.e. the response of such muscle to epinephrin in relation to the influence of female sex hormones. It has been known for a long time that the uterus of the virgin cat responds differently to stimulation of the hypogastric nerves *in vivo* or to treatment with epinephrin both *in vivo* and *in vitro* from that of the animal in pregnancy. The normal virgin uterus of the cat is relaxed by epinephrin but the uterus of the pregnant cat *in vitro* contracts when treated with the same drug. This remarkable reversal of the usual response of the cat's uterus to epinephrin suggested to Van Dyke and Gustafson that the explanation of the phenomenon might lie in an

the corpus luteum in particular may be noted in this place to complete an exposition of the various reactions given by that hormone Hisaw (34), who has done a great deal of work on female hormones, described a relaxant effect which corpus luteum extract exerted on the symphysis pubis of guinea pigs and rabbits, a relaxation similar to that occurring in all these animals during pregnancy. This reaction Hisaw found to be so characteristic that he ascribed it to the specific hormone contained in corpus luteum, which he named "relaxin"

Studies on spontaneous or voluntary activity of skeletal muscles of rats placed in rotary cages were made by Slonaker, Wang (97, 98) and associates. The latter authors first established the normal cycle of activity in rats and then studied the effects of ovariectomy and the influence of subsequent injection of various solutions of female hormones on the same animals. The results obtained were not especially significant.

A different kind of psychological study on the ovarian and corpus luteum hormones was published by Macht and Seago (61). The behavior of white rats trained in a circular maze was carefully established and their running time was measured. Ovariectomy was performed and after the rats had recovered from such an operation their muscular activity and general behavior were again observed. Small doses of ovarian and corpus luteum extracts were then injected. The results of these experiments indicated that ovarian extract in general and extract of corpus luteum definitely improved the running time and cerebral responses of both normal and ovariectomized rats.

A third reaction obtained by Macht and Matsumoto (60) with ovarian and corpus luteum extracts on the pupils of frogs' eyes may also be mentioned. These writers tested the action of 10 per cent solutions of corpus luteum and ovarian substances on frogs' eyes and noted that corpus luteum produced dilatation and the ovarian extract no effect whatever.

Finally, mention should also be made of the interesting findings reported by Kanter, Bauer, and Klawans. These writers discovered that

the growth of the ovipositors of Japanese bitterlings was stimulated by feeding them with estrogenic preparations of the ovary. In this connection the present writer made some tests in which a desiccated corpus luteum preparation was fed to bitterlings by a method described elsewhere. Bitterlings placed in water containing preparations of follicular hormone showed marked elongation of the ovipositors in from 24 to 48 hours. In a series of experiments in which corpus luteum and follicular extracts, in suitable proportions, were administered simultaneously to these fish, a definite inhibition resulted; i.e., the elongation which the follicular hormone would have effected was antagonized by the corpus luteum extract and no stimulation to growth was consequently observed. Such experimentation, while not extensive, is mentioned briefly in this place (59). Kleiner and his associates have recently expressed some doubt as to the reliability of the bitterling reaction to the follicular hormone, on the one hand, and claimed, on the other, that the female bitterling is a specific physiological test animal for the male hormone.

EVALUATION

The abundant data, physiological and pharmacological, assembled in this paper (which, if space permitted, could be extended) afford sufficient evidence, beyond reasonable doubt, of the important endocrine function of the corpus luteum. Whether one or more hormones contained in that gland are responsible for the various physiological effects noted by different observers is not yet definitely established. Unquestionably the corpus luteum through its internal secretion plays an important rôle with regard to the course of pregnancy and in primates exerts an influence on the menstrual cycle as indicated by gross anatomical and histological changes in gonads and accessory organs. Of particular interest from the standpoint of practical therapeutics are those experiments in which corpus luteum preparations or extracts have been injected into animals, normal and castrated, for the purpose of influencing their physiological function. These indicated the close relationship and interdependence of the corpus luteum and estrogenic or follicular hormones. It

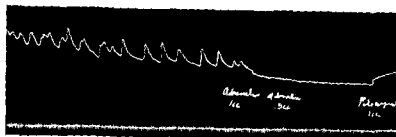


Fig 7 Effect of adrenalin on uterus of virgin cat which had been daily injected intraperitoneally with lutein (H W & D) for 8 days the total amount injected being 18 cubic centimeters. Note inhibition of contractions but no relaxation of muscle.

glandular extracts on the uterus, fallopian tubes, seminal vesicles vas deferens bladder, and ureters of various kinds of animals were carefully studied.

It was found that while aqueous or saline extracts of all sorts of glands (with the exception of the suprarenal) effected but a mild stimulation of smooth muscle preparations, corpus luteum extracts produced an extraordinary stimulation of vasa deferentia of rodents, particularly of white rats. Even minute quantities of such corpus luteum extracts produced powerful contractions of the vas which, within biological limits were proportional to the amount of the extracts used.

Extracts of whole ovary also stimulated the vas deferens of the rat to some extent but it was demonstrated that such contraction was effected by the corpus luteum present in the preparations. When ovarian or follicular extracts free from corpus luteum were examined in this way, the response was very weak. These observations of Macht and Matsumoto (69) suggested a simple and ready method of comparing the activity of corpus luteum preparations. Such a method, used by the writer and his associates (64) yielded data in remarkable agreement with results reported by clinicians employing the same preparations.

The curious anomaly of a male genital organ exhibiting specific sensitivity for a female sex hormone, namely corpus luteum, puzzled the writer working originally on this subject. At the present time such a phenomenon is by no means an unusual one. Reference has already been made to certain "antimale" reactions elicited by estrogenic hormones. Again,

the extensive studies on the effect of estrogenic female hormone on the estrus cycle of rats and mice reported by numerous investigators, have eventually led to the discovery that this so called female hormone is widely distributed in nature not only among animals but also among plants and that it can be extracted in large quantities from the urine of men as well as that of pregnant women.

D Response of fallopian tubes. The relation of the female sex hormones to the movements of the genital organs is of interest in another respect, namely in regard to the rhythmic contractions these hormones produce in the fallopian tubes. Some of the most interesting studies reported on the subject have been those which Seckinger published from this laboratory. The effect of ovarian and corpus luteum extracts on the normal rhythmic contractions of the fallopian tubes of the pig *in vitro* was carefully observed. It was found that there was a distinct difference in the type of contractions produced by corpus luteum and whole ovary extracts, respectively. Here again earlier experiments take on a new significance in the light of the results herein cited with regard to the relation between corpus luteum and the pharmacodynamic properties of pituitrin and epinephrin. Thus we have described at least four different smooth muscle reactions which distinguish between the follicular hormone and the hormone of corpus luteum.

7 MISCELLANEOUS EFFECTS OF CORPUS LUTEUM

A number of other physiological effects produced by female hormones in general and by

and lower animals The isolation of the various active principles of ergot scored another triumph for modern pharmacology, nevertheless, few are the skilled obstetricians who would administer small quantities of the same in preference to the well standardized galenical preparations of the drug. The chemistry of digitalis leaf, the most important heart drug at the service of the medical man, has not been entirely established Some twenty different glucosides and other chemical bodies have been isolated from this plant and the pharmacological action of each has been carefully studied but neither digitoxin nor any other powerful pure digitaloid principle, administered separately, is as satisfactory therapeutically as the leaf itself or the official tincture and infusion of the plant

In their search for active principles those who are interested in practical therapeutics must not lose sight of the important fact that two or more drugs may profoundly modify the action of each other in not only the pharmacological but also the physicochemical sense of the word Thus, pharmacologically, one chemical may antagonize or potentiate the effect of another. Again, in a purely physical way, the combination or mixture of two or more bodies may serve to keep all in solution as, for instance, in case of the digitalis glucosides The *total ensemble* or combination of medicinal principles in the proportion in which they occur in nature is often much more effective for clinical purposes than any artificial mixture of pure principles. Such possibilities should be borne in mind when the efficiency of the female sex hormones and their preparations is considered, especially by those medical men who are interested in their practical therapeutic use. As our knowledge of the subject accumulates, we begin to doubt even such phenomena as those heretofore considered absolutely reliable criteria Thus, for instance, in a recent paper Freed and Soskin suggest that the potency of an estrogenic substance as regards cornification bears no constant relationship to its potency as regards other important physiological properties, and therefore in their opinion an assay of estrogenic substance by the vaginal smear method alone is no absolutely reliable

indicator of its potency as regards other physiological properties or as regards its possible value in therapeutics. We have not yet solved the physiological puzzle of the sexual cycle in higher animals, much less that of primates. This cycle is controlled by such an intricate and delicate system of checks and balances, depending not only on the hormones of the ovarian follicle and corpus luteum but also upon the internal secretions of the pituitary, thyroid, and suprarenal glands, that any attempt at rational substitution therapy with isolated, so called chemically pure hormones may well be considered hazardous until the whole subject of internal secretions and their physiological function is thoroughly understood. It may be much wiser for the clinical practitioner to employ carefully prepared extracts of the whole ovary or of the corpus luteum, approximating as closely as possible the normal content of the gland in its natural state unmixed with products of disintegration, rather than to experiment with combinations of allegedly "pure principles," the physiology, chemistry, and even posology of which are still unsettled.

SUMMARY

1. A résumé of all kinds of experimental data found in scientific literature regarding the physiological function of the corpus luteum is presented.
2. Three lines of investigation by the writer and his collaborators with water-soluble corpus luteum preparations are described.
3. A study of vaginal smears revealed that injections of corpus luteum extracts distinctly inhibited the estrus cycle of guinea pigs.
4. Injection of corpus luteum extracts in mice inhibited a tendency to hypertrophy of the uterus induced by injections of estrogenic follicular extracts
5. Corpus luteum extracts elicited characteristic responses from uterine muscle of guinea pigs and cats, fallopian tubes of pigs, and vasa deferentia of white rats.
6. In the three classes of experiments the same extracts induced parallel and comparable results, thus demonstrating that the activity of corpus luteum preparations may be shown by several convenient methods

appears that these two groups of hormones in some respects exert diametrically opposite physiological effects. This antagonism is only apparent, however, and should be regarded as a *synergism promoting the normal functioning of the sexual apparatus*. Experimentally there is no longer any doubt as to the inhibitory effect of corpus luteum on the estrus of small animals. The most recent work on the subject corroborates this view. Thus, Dessau notes that "daily injections of estrone, estrinol, or estradiol into mature guinea pigs (castrated or normal) cause proliferation and metaplastic changes of the uterine epithelium. These changes are inhibited by corpus luteum hormone." These findings are in complete agreement with the results obtained by Macht, Stickels, and Seckinger.

A discussion of the chemical nature of the various extracts or "active principles" obtained from the corpus luteum by different investigators does not come within the scope of this paper. However, although almost every investigator studying biochemical phases of the subject is inclined to regard the particular extract or preparation that he has been using as the most efficient, an impartial examination of the literature reveals that physiological effects have certainly been obtained with both the lipid soluble and the aqueous extracts of corpus luteum.

The writer and his co workers have experimented with all kinds of extracts prepared from corpus luteum substance. Some of these were prepared with ether, others with petroleum ether, acetone, chloroform or ethyl acetate, and still others with alcohol. All the extracts prepared though they were in different ways exhibited more or less activity when tested by various methods. The authors obtained the most satisfactory clinical results however, with a water soluble extract made by treating desiccated corpus luteum substance with alcohol for a prolonged period, deproteinizing it with lead acetate, filtering and removing the lead and adjusting the hydrogen ion concentration of the resultant solution. It was found that preparations so obtained prolonged the interestrual interval in guinea pigs and rats and were also quite active in producing the peculiar and specific

reactions of smooth muscle preparations from the uterus and vas deferens previously described. When the curves obtained by the writer with uterine preparations in response to posterior pituitary hormone were compared with those of other investigators, it was found that the effect produced by 1 milligram of crystalline progesterone was approximately equivalent to that resulting from repeated injections of 10 cubic centimeters of lutein solution (H.W. & D.). The author and his co workers found furthermore that the activity of corpus luteum preparations in guinea pigs tested by the vaginal smear method ran parallel to their effects on the vas deferens of the rat, on the one hand, and on the uterus of the rabbit with respect to its response to posterior pituitary hormone, on the other. The potency of such preparations in clinical practice has been attested by reports from a host of physicians who have made carefully controlled studies on patients with all kinds of female hormone products. In the experience of the writer and his co workers, the various physiological effects of corpus luteum were obtained not only by injection of extracts but also by prolonged feeding of desiccated corpus luteum.

Whether a single active principle or a mixture of active principles occurs in the various extracts of female gonads employed in these studies has not yet been ascertained. From the standpoint of practical therapeutics, however, the value of isolated active principles separated from the synergistic bodies which the various glands contain in their natural state, is still debatable. Thus for instance, the discovery and isolation of the chemically pure thyroxin, active principle of the thyroid gland, marked a great advance in biochemical science, yet in clinical practice this principle administered alone has proved less effective than many of the ordinary thyroid preparations on the market. The isolation and chemical identification of various vitamins marked similar progress in biological science but the value of administering minute quantities of pure vitamins separately in cases of defective nutrition is still disputed. In fact such treatment has already been reported to produce dangerous pathological changes in man.

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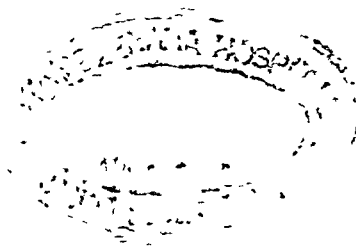
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factor in producing cholecystitis. Many authors have inoculated the bacteria directly into the wall and cavity of the gall bladder. The results obtained in these cases are even more contradictory. Cushing, using typhoid bacilli injected into the rabbit's gall bladder, and Italia, using *Bacillus coli* and *Bacillus typhosus* in both rabbits and dogs, obtained inflamed gall bladders with stone formation. Rosenow, working on his idea of the "selective affinity" of bacteria (especially streptococcus and *Bacillus coli*) to certain organs and tissues, tried to establish a connection between "foci of infection" and gall-bladder disease. He used both the intravenous and the direct inoculation methods, and obtained contradictory results, as in certain cases in which the intravenous route produced marked cholecystitis, direct inoculation into the gall bladder was ineffective. Schoebl was more successful in producing cholera carriers by direct inoculation than by intravenous injection. Meyer and coworkers, using typhoid bacilli, obtained positive results with both methods.

Doerr observed that excretion of typhoid bacilli into the bile, which occurred regularly after the injection of the former into the systemic veins, could be prevented by ligation of the cystic duct. Koch and Chiarolanza, however, arrived at opposite conclusions. They found typhoid bacilli in the gall bladder after intravenous injection even after a preceding cystic duct ligation.

Nichols produced "lesions of the gall bladder" in a high percentage of cases by injecting typhoid bacilli into the mesenteric or ear veins. Emmerich and Wagner obtained similar lesions by direct inoculation of typhoid bacilli into the rabbit's gall bladder. Venema's experiments, however, performed under similar conditions, revealed no changes in the gall bladder.

In connection with the "specific affinity" idea of Rosenow we ought to mention the work of Brown, who found mainly streptococci in the emulsified gall-bladder tissue from cases of human cholecystitis. He demonstrated serologically the direct etiological importance of these streptococci and proved their specific affinity for the gall bladder by intravenous injection in rabbits.

Staphylococci are used in the experimental work of Magner and Hutcheson. These authors produced a change in the gall bladder wall by injecting these organisms under the serous layer, while this change occurred in only a limited number of cases following injection into the lumen.

More recently Rehfuess and Nelson studied the problem of gall-bladder infection in the experimental animal and concluded that a variety of organisms when injected intravenously in the rabbit, can produce lesions of the gall bladder.

Evidence other than infection in the literature. Much doubt has been expressed on different occasions on the accuracy of the theory that infection plays the primary rôle in the etiology of gall-bladder lesions. Clinical observations caused various authors to search for some other cause.

On the basis of his clinical observations, Denton was not able to accept the theory of infection and suggested mechanical and circulatory disturbances as the causes of the gall-bladder pathology. Similarly Feinblatt concludes from his pathological studies that mechanical and metabolic factors are important parts in the production of cholecystitis.

One metabolic disturbance in particular has found a prominent place in the literature in this connection, i.e., the cholesterol metabolism. The "strawberry gall bladder," first described by Moynihan, occurs under certain pathological conditions of cholesterol metabolism. Boyd considers infection to be the cause of this metabolic disturbance. Wilkie and Rosenow obtained positive cultures from the wall, the gall-bladder contents and stones of such cases. The importance of cholesterol in stone formation is well known and need not be taken up here. There is no evidence, however, in the literature, of acute inflammatory changes in the gall-bladder wall in connection with a disturbance in cholesterol metabolism.

As compared to the enormous amount of literature on cholecystitis brought about experimentally by bacterial infection, relatively little is known about chemical cholecystitis.

Well known is the work of Mann who produced acute changes in the gall-bladder

EXPERIMENTAL CHOLECYSTITIS

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A REVIEW of the literature on the etiology of gall bladder diseases reveals that 9 of 10 publications consider bacterial infection to be the most likely agent. Some uncertainty as to the accuracy of this view is evident, however.

The first to associate gall bladder inflammation with infection was John Hunter, who first observed cholecystitis in typhoid fever patients. Gilbert and Girode proved this relationship bacteriologically, while Chiari added clinical evidence in support of this view. The idea was quick to take and was soon confirmed by many authors. Doubt, however, was early expressed. Rolleston emphasizing the need for an additional factor than infection, basing his idea on the clinical fact that cases of cholecystitis were increasing coincident with a marked decrease in the occurrence of typhoid fever. This is confirmed by Osler's report of 19 cases of cholecystitis in a series of 1,500 cases of typhoid fever while it is well known that most cases of typhoid fever have a large number of organisms in the bile. Furthermore the theory of the relationship between typhoid fever and gall bladder disease was an intimate one and received its death blow in the fact that the former has practically disappeared from all civilized communities without any appreciable lessening in the evidence of gall bladder disease.

Organisms other than typhoid bacilli have also been incriminated. Much valuable information was obtained by culturing the bile and the walls of gall bladders obtained at post mortem examinations and at operation. Table I is taken from the article by Rehfuess and Nelson (43) and needs little comment. Both Andrews (3) and Wagner, studying the content of human gall bladders removed at operation, have found 65 per cent of cases to contain sterile bile. Osler places this figure at

52 per cent. According to the study of Wagner and Hutcherson, *Bacillus coli* is the most common organism in the cavity of the gall bladder, while streptococci are found more often in the gall bladder wall. Drennan emphasizes the anti bacterial activity of bile on account of his small percentage of positive cultures. Scarcity of clinical signs of infection the low fever, the mild leucocytosis and the rareness of leucocytes in the bile convinced Denton that infection does not play a primary role in the production of cholecystitis. Feinblatt concurs in this opinion on the basis of the slight inflammatory changes he observed in the gall bladder wall and the small amount of leucocytes in the bile. In contrast to this idea, Huntemueller found positive bacterial cultures in 100 per cent of cases when he included both the gall bladder wall and the liver. The finding by Koch and Chiarolanza of emboli in the folds of the mucous membrane led to the conclusion that a transverse infection of the wall is the usual route.

EXPERIMENTAL LITERATURE

The amount of experimental work done to prove the theory of infection as playing the leading part in the etiology of cholecystitis is enormous. Most authors have tried to confirm their clinical observations by animal experimentation. The various techniques employed are emphasized in the following discussion, as differences in results might be due in some cases to variations in the methods employed.

Intravenous injection of bacteria has been a popular method. *Bacillus typhosus* was found in the bile fairly regularly by Blackstein several days or weeks following intravenous injection of this organism. Sherrington using *Bacillus anthracis*, *Bacillus pyocyaneus* and staphylococci recovered the organisms in the bile in only 18 out of 49 cases. The condition of the walls of the gall bladders was not mentioned in these experiments. Gilbert (23) considered *Bacillus coli* the most important

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present opinion on the subject. The theory of infection is questioned, but while other theories are suggested, none is actually proved.

Experimental results vary considerably, and often are even contradictory. This may be due to differences in the technique employed by various investigators.

The disadvantage of the most commonly used method, *i.e.*, introduction of bacteria by means of a needle puncture through the gall-bladder wall, was recognized by many early workers. Rosenow found damage to the gall-bladder wall, in many instances, at the point of injection. Venema found this damage to be severe in extent, an observation which is confirmed by Wilkie.

Venema then tried to improve the needle puncture technique by cauterizing the wall at the point of injection. He obtained normal gall bladders in this way, while Emmerch and Wagner had produced changes of the wall. Hospers performed the injection through the liver surface of the gall bladder, a method which leaves the free surface unharmed but may cause occasional bleeding in the liver tissue.

Intravenous injection of bacteria as practiced by Rosenow and others is a much more satisfactory method. Positive reactions in the gall bladder after such injection seem to indicate a specific affinity of these bacteria for the biliary system. Negative results, however, are of lesser value, since we have no way of proving that the organisms actually reached the gall bladder. They might still possess some definite affinity for the gall bladder if brought there in some other way. Another disadvantage of the intravenous method is the bacteriemia which is produced, and which is usually not present in human cholecystitis.

In the production of experimental cholecystitis the dosage used in most cases has been so extreme that it can hardly be compared to any possibility offered by focal infection in man. Several observers have stated that the liver was a rather efficient filter for bacteria in the blood and that only when overwhelming doses were given did any appear in the bile. Furthermore some state that trauma must be added to cause infection to spread from bile to gall bladder if injection be made locally.

We have often made the observation in sampling the gall bladders of dogs that the needle punctures were seen to react sharply. The next day there is usually an area about a centimeter in diameter which histologically closely resembles acute cholecystitis. For these reasons the development of a special technique was important. Needle puncture is, of course, ruled out. Closure of the ducts alone has previously been shown to cause severe damage to the gall-bladder wall. Therefore the following technique was adopted.

A NON-TRAUMATIZING TECHNIQUE

Experimental cholecystitis from which conclusions can be drawn concerning human cholecystitis requires 3 basic postulates: (1) the cholecystitis must be a direct result of the material used; (2) the material introduced must be such as is normally found either in the body fluid or in the ingested food and should not be artificial and foreign to the body; (3) the reaction produced in the experimental animal must be similar in appearance to human cholecystitis.

We have found a technique which fulfills the third requirement in a satisfactory manner. The principle of our technique is the retrograde introduction of a fine ureter catheter into the gall bladder through an opening in the common duct and the subsequent plastic repair of the duct by insertion of a glass cannula.

A detailed description of this technique, which was applied in dogs only, follows.

The dog's abdomen is opened under ether anesthesia by an incision in the upper midline. The duodenum is lifted aside and the common duct is freed by blunt dissection from the surrounding tissue. A longitudinal incision, about 1 centimeter long is made in the duct about 1.5 centimeters distant from its entrance into the duodenum, and the margins of this opening are clamped by a mosquito forceps. A soft French rubber catheter, 25 to 35 millimeters in diameter is then introduced through this opening into the gall bladder. Bile is aspirated and the particular material we are testing is injected into the gall bladder through this catheter. Before the catheter is withdrawn and the glass cannula is inserted,

wall by the intravenous injection of Dakin's solution. Dilatation of the lymphatics, breaking down by blood are the typical microscopic changes. In another series of experiments, changes of the gall bladder wall were brought about by the direct introduction of chemically or mechanically irritating substances, as for instance mustard oil, used by Darnbacher and Sacks.

The effect of x ray radiation was shown by Brans and Darnbacher to consist of an acute inflammatory change in the gall bladder wall.

PHYSIOLOGY OF THE GALL BLADDER

Any discussion of the problem of gall bladder diseases requires first a precise knowledge of the function of liver cells as well as the chemical and biological characteristics of bile. The gall bladder is more than a container to store bile. We know from the extensive investigations of Peyton Rous, and McMaster that the gall bladder concentrates liver bile to a great extent. Andrews (2) has shown that the function which the human gall bladder performs has been greatly underestimated. This fact is of importance for the proper understanding of the disorders of function which are often found after cholecystectomy. The gall bladder ought not to be considered as just a useless appendix to the liver which can be removed without any risk. Bile itself offers many biochemical problems. The extensive use of bile as a medium for culturing bacteria is well known. However there is no uniform behavior for while bile favors the growth of certain organisms it has an inhibitory effect on others.

The greatest difficulty arises in studying the chemical composition of bile. Cholesterol, bilirubin and calcium have been studied by many authors in connection with stone formation and pregnancy.

Modern investigation has shown that cholesterol is kept in solution by bile acids and that precipitation of cholesterol occurs when the bile acids are diminished.

While biochemists are studying the various fractions and chemical formulas of bile salts very little is known about their biological importance. The modern conception is that the bile salts are produced in the reticulo-

endothelial system, excreted by the liver concentrated in the gall bladder, excreted into the intestines, and reabsorbed by way of the portal system. Their function in emulsifying fats is well known but very little else about their normal functions is known. It is therefore, not surprising that still less is known about the rôle they play under pathological conditions.

PATHOLOGICAL ANATOMY

Little information is added from anatomical studies as to the etiology of cholecystitis.

Gall bladders, removed at operation for acute gall bladder disease, often prove to be either perfectly normal at microscopic examination or show changes which are in no way sufficiently characteristic to classify them into one pathological group.

However in a great number of cases a definite anatomical picture is found. We will give a short description of these lesions to serve as a comparison with the results obtained in experimental work.

Henke and Lubarsch compare the findings in acute cholecystitis with those found in acute appendicitis, the purulent infiltration of the wall however being less pronounced in the former case. The character of the exudate is seropurulent. The process begins in the intramuscular pits of the mucous membrane the so called *Luschkaschen Gaenge*. Later the entire wall especially the serosa becomes involved. Thickening of the gall bladder is due mainly to edema in the outer layers.

The description given by modern American authors such as Graham Boyd, Andrews, Fenblatt and others differs in that the presence of pus cells in acute cholecystitis is practically denied. Edematous thickening of the serosa with round cell infiltration, dilatation of the lymphatics and deposition of a fibrinous exudate on the serosa are the common findings. The mucosa is very often normal while some round cell infiltration is often found in the muscularis.

REASONS FOR A NEW APPROACH TO THE PROBLEM

From this review of the literature on cholecystitis one can see the confused status of

tion Mononuclear cells are prevalent, while pus cells are rarely found, not even in cases of so called "empyema," in which the gall bladder content usually consists of amorphous debris or cholesterol crystals rather than of true pus

2 Bacteria are seldom found in stained sections of the gall-bladder wall and the bile is found to be sterile in a high percentage of diseased gall bladders

3 Finally there is the clinical observation that sepsis is a rare complication of cholecystitis and that the gall bladder is rarely involved in cases of pyemia

To prove or disprove the infectious theory, the following series of experiments were carried out:

Bacteria obtained from human sources, such as acute and chronic mastoiditis, sinusitis, adenitis, etc., were introduced into the gall bladders of dogs by means of the catheter-cannula technique. The cultures were of recent isolation. The bacteria used for the injection were suspended in saline solution in a concentration of approximately 500 million bacteria per cubic centimeter, the criterion used being the cloudiness of the suspension as compared with one of known bacterial content. One cubic centimeter of this suspension was the amount generally injected. Wherever the reaction obtained was especially severe, the experiments were repeated with smaller amounts, while 2 or 3 cubic centimeters were injected in cases in which no reaction occurred.

Tables I, II, and III give detailed description of the 26 experiments.

Cholecystitis 1 indicates a gall bladder with only few changes, slight edema, and congestion in the serosa being the only pathological findings.

In cholecystitis 2, the gall-bladder wall was thickened up to 4 millimeters, the acute inflammatory signs were more definite, and a thin fibrinous membrane covered the serosa.

Cholecystitis 3 includes all those cases in which the changes exceed those in group 2 as to thickness of the wall and the extent of inflammatory signs. Whenever the introduction of the catheter or the insertion of the cannula was attended with difficulty, the term "traumatization" was included in the column label-



Fig 2 Microscopic appearance 20 minutes following the intravenous injection of commercial bile salts. Marked edema of serosa about four times normal thickness.

ed "complications." Wherever this happened, or in those experiments in which the common or cystic duct was tied, results are of value only when the gall bladder remained normal in spite of the bacterial injection or duct ligation or traumatization.

RESULTS

Special emphasis is laid in our experiments upon the studying of *Streptococcus hemolyticus*, which has been accused of being the main causative agent in the production of cholecystitis in both animal experimentation and in man. Four different strains of *Streptococcus hemolyticus* were used in 12 injection experiments. Although three of the four strains were taken from acute human infectious processes, changes of the gall-bladder wall occurred in only one of these.

These changes, however, occurred in all 3 of the cases, in which this particular strain

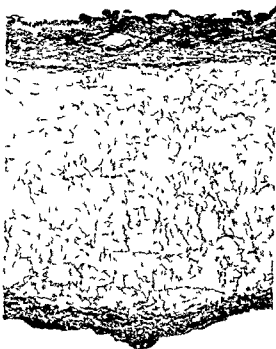


Fig 1a Microscopic appearance 48 hours following the introduction into the gall bladder of commercial bile salts 15 per cent. Note edematous thickening of the serosa five times normal with fibropurulent exudate on serosal surface.

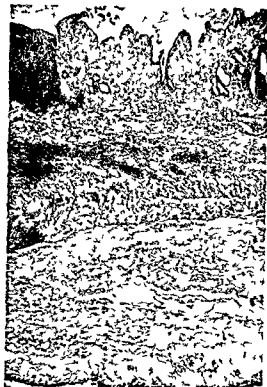


Fig 1b Microscopic appearance 48 hours following the introduction into the gall bladder of sodium desoxycholate 8 per cent. Diffuse leucocytic infiltration of all three layers.

a rubber protected clamp is placed around the common duct as close to the gall bladder as possible. This is necessary to prevent a back flow of bile.

The cannula which is 3 centimeters in length and 4 millimeters in diameter tapering at the ends and grooved transversely a short distance from the tips on each side is inserted into the common duct and kept in place tightly by 2 ligatures around the grooved surfaces. After the duct is unclamped and a rather normal bile flow is observed the edges of the opening are sutured together above the cannula.

Since during the whole procedure which takes about 20 minutes the gall bladder is not even brought into view we feel sure that the factor of traumatization is practically negligible.

That this is actually the case has been proved by a great number of control experi-

ments. In some cases bile was aspirated and nothing injected while in others the gall bladder was thoroughly washed with normal saline solution. The animals were electrocuted 24 or 48 hours after operation and the gall bladders were found to be perfectly normal on gross and microscopic examination.

Absence of reaction in the gall bladder shows that by use of the technique described experimental manipulation of the gall bladder is possible without any traumatization.

THE THEORY OF INFECTION AND THE OBJECTIONS TO IT

The main arguments against the infectious theory of cholecystitis based on anatomical and clinical observations are summarized as follows:

1. Pathological studies of diseased gall bladders reveal few signs of bacterial infec-

tion Mononuclear cells are prevalent, while pus cells are rarely found, not even in cases of so called "empyema," in which the gall bladder content usually consists of amorphous debris or cholesterol crystals rather than of true pus.

2 Bacteria are seldom found in stained sections of the gall-bladder wall and the bile is found to be sterile in a high percentage of diseased gall bladders

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TABLE I REVIEW OF 4395 CASES OF CHOLECYSTITIS*

Bacterial Study in 2162 Cases Exclusive of Rovsing's 530 Cases

Author	No. Cases	Bact. cultures	Contents cultures	Stones present	Strep. cultures	Acute cases	Acute cultures	Chronic cases	Chronic cultures	Findings at necropsy: m to end of life only
Blalock	170		58							B. coli 49% B. typhosus 14% Staphylococcus 14% St. epidermidis 20% Streptococcus 14% B. coli 14% d. Streptococcus 14% B. coli 14% Other cases collected from 1906 to 1915 at Johns Hopkins
Branch	20	33		24	21	57	42	153	11	B. coli Staphylococcus Streptococcus
Brown	70	10				20	15	50	1	Streptococcus B. coli
Bu den	17									Cholecystitis is not usually the result of an acute process but rather a result of mild infection—slowly affecting different layers of the gall bladder. Cholecystitis is favored by the anatomy and histology of the organ which predisposes to stasis and obstruction.
Deane (1)	57	20 (14 positive cystic nodes & negative cystic nodes)	7							
Devere (2)	903	No bacterial study made		451						Concept: non-moderate primary hepatic often preceded by appendicitis
Denton	403			188						Failure to demonstrate lesions in primary biliary cirrhosis or other than infection (mechanical and circulatory) are necessary for explanation of the majority of lesions commonly observed in the gall bladder
Dorman	100	34								B. coli St. typhosus Streptococcus
Fenblatt	400			120						B. coli predominate in pus of abscess (pyem) cases
Friesleben	132	73 of 96 exam	62 of 13 exam							B. coli
Go don Taylor and Whitby	50	42	20	50	4					B. coli 30% St. typhosus locally 25% B. coli 15% St. typhosus 30% others 15%
Hingworth	100	62	40	62	7	1	0	88	5	Streptococcus B. coli Staphylococcus
Johnson	100	3	3	66	6	0	13	78	18	B. coli Staphylococcus Streptococcus
Judd	200	98	6 of 107 m	107	4 of 64 exam					Streptococcus B. coli Staphylococcus
Kelly	140	113								B. coli B. typhosus Staphylococcus aureus
Magnus and Hitchenson	200	78		19						St. epidermidis (typical) 30% B. coli 10% (atypical) Staphylococcus 7% others 30%
Magnet and Hutchison			34 of 95 exam							B. coli 17% Streptococcus (typical) 20% Staphylococcus (atypical) 37% other 15%
Moynihan	81	50	25							
Rosenow	76	51 of 61 exam	30 of 61 exam		57 of 61 exam					Streptococcus B. coli
Rovsing	530			530	6					
Williams and Metachian	106	5 of 90 exam	43 of 91 exam	47	14	4	3	03	43 of 84 exam	B. coli Enterococcus Staphylococcus B. welchii & others
Wilk (1)	50	6	0							Streptococcus B. coli from 4 to 5 cystic glands—43% St. epidermidis
Wilk (2)	100	84								Streptococcus dans

TABLE IA—STREPTOCOCCUS HÆMOLYTICUS*

Experiment No	Strain injected	Amount	Method of introduction	Duct open except where ligation stated	Complications and results
1	Acute mastoiditis, 1	0.5 c cm	Catheter	Cannula	Dying when electrocuted. Cholecystitis 3, bile peritonitis
2	Acute mastoiditis, 1	3 drops	Catheter	Cannula	Died. Cholecystitis 3, postmortem changes
3	Acute mastoiditis, 1	3 drops	Catheter	Cannula	Very sick. Cholecystitis 2-3
4	Acute sinusitis	2 c cm	Catheter	Cannula	Gall bladder normal
5	Acute sinusitis	1 c cm	Catheter	Cannula	Gall bladder about normal
6	Acute sinusitis	2 c cm	Catheter	Cannula	Gall bladder normal
7	Acute sinusitis	1 c cm	Catheter	Cannula	Cholecystitis 1
8	Acute sinusitis	1 c cm	Needle puncture	Common duct ligation	Thickening of gall-bladder wall
9	Acute sinusitis	1 c cm	Catheter	Cannula	Gall bladder about normal
10	Acute mastoiditis, 11	1 c cm	Catheter	Cannula	Gall bladder normal
11	Acute mastoiditis, 11	1 c cm	Catheter	Cannula	Gall bladder normal
12	Chronic mastoiditis	1 c cm	Catheter	Cannula	Gall bladder normal

*Streptococcus hemolyticus in strain from (1) acute mastoiditis, 3 dogs, (2) acute sinusitis, 6 dogs, (3) acute mastoiditis 11, 2 dogs (4) chronic mastoiditis, 1 dog

had been injected. Death of the animal within 15 hours after injection resulted in one instance, while another animal was moribund in 24 hours, and the third one in very poor condition when killed.

In contrast to these experiments the dogs into which the other three strains of Streptococcus hemolyticus were injected, showed no signs of illness. Postmortem examination after electrocution revealed either normal gall bladders or changes which were very slight and not of an inflammatory character.

Table II shows that Bacillus coli has no effect on the gall-bladder wall. This chart demonstrates clearly the value of a proper technique. In two animals where traumatization occurred or duct ligation had been performed, severe reactions were produced, which cannot be attributed to the action of the bacteria, since bacterial injection by means of the catheter-cannula technique revealed definitely negative results.

Similarly we conclude from Table III that none of the organisms used in this series can produce cholecystitis.

On microscopic examination, we find in the gall bladders, where the strain of Streptococcus hemolyticus from acute mastoiditis had been injected, an enormous thickening of the serous layer, which is mainly due to edema and hyperemia. The serosa is infiltrated with

leucocytes and covered with a fibrinous exudate. Those gall bladders, however, into which had been injected another strain of Streptococcus hemolyticus or any of the other bacteria named in the charts either proved to be normal or revealed only very slight changes.

In summarizing these experimental results we may conclude that there is little tendency for acute bacterial infection of the gall-bladder wall to result from any of the contents of the organ. Bacteria, although present in bile in

TABLE II—BACILLUS COLI

Experiment No	Bacillus Coli c cm	Method of introduction	Duct open except where ligation stated	Complications and results
1	1	Catheter	Cannula	Gall bladder normal
2	1	Catheter	Cannula	Gall bladder normal
3	2	Catheter	Cannula	Gall bladder normal
4	1	Catheter	Cannula	Some traumatization Cholecystitis 1
5	1	Needle puncture	Common duct ligation	Some traumatization, died Cholecystitis 3 postmortem change, bile peritonitis
6	1	Needle puncture	Common duct ligation	Very sick. Dilated gall bladder with fibrinous exudate
7	1	Needle puncture	Common duct ligation	Gall bladder about normal
8	1.5	Needle puncture	Cystic duct ligation	Slight reaction on gall bladder

TABLE III—MISCELLANEOUS BACTERIA*

Experiment No.	Bacteria injected	Amount in c. cm.	Method of introduction	Duct open except when ligation stated	Complications and results
1	Staphylococcus albus	1	Catheter	Cannula	Gall bladder normal
2	Staphylococcus albus	1	Needle puncture		Gall bladder normal
3	Staphylococcus albus	1	Needle puncture	Cystic duct ligation	Traumatization slight reaction on gall bladder
4	Staphylococcus aureus	1	Catheter	Cannula	Gall bladder normal
5	Staphylococcus aureus	1	Catheter	Cannula	Gall bladder about normal
6	Staphylococcus aureus	1	Catheter	Cannula	Gall bladder normal
7	Staphylococcus aureus	1	Catheter	Cannula	Bile peritonitis some reaction on gall bladder
8	Staphylococcus aureus	1	Needle puncture		Slight reaction on gall bladder
9	Staphylococcus aureus	1	Catheter	Common duct ligation	Died Cholecystitis 3 postmortem changes
10	Streptococcus viridans	1	Catheter	Cannula	Gall bladder about normal
11	Streptococcus viridans	1	Catheter	Cannula	Gall bladder normal some bile peritonitis
12	Streptococcus viridans	1	Catheter	Cannula	Gall bladder normal
13	Bacillus welchii	1	Catheter	Cannula	Gall bladder normal
14	Bacillus welchii	0.5	Catheter	Cannula	Gall bladder normal
15	Bacillus welchii	1	Catheter	Common duct ligation	Traumatization 2 d. Postmortem changes on gall bladder
16	Bacillus welchii	0.5	Needle puncture	Common duct ligation	Gall bladder about normal

* (1) Staphylococcus albus 3 dogs (2) Staphylococcus aureus 6 dogs (3) Streptococcus viridans 3 dogs (4) Bacillus welchii 4 dogs

overwhelming numbers, do not cause any change in the gall bladder wall unless they are of unusually great virulence.

These results concur with the observations of Rosenow and of Magner and Hutcheson, who stressed the varying activity within the Streptococcus hemolyticus group on the basis of differences in virulence. The negative results, however, which we obtained in using Bacillus coli stand in direct disagreement both with the clinical data reported by Gilbert and the experimental work done with this organism by Italia. The negative results after the injection of Staphylococcus albus and aureus, Streptococcus viridans and Bacillus welchii agree with results reported in the literature.

CHEMICAL CHOLECYSTITIS

Mechanical factors can produce lesions in a gall bladder containing stones. There is little doubt that the presence of one or more stones in the gall bladder or the impaction of a stone in the cystic or common duct can

lead to marked changes in the gall bladder wall. However, at postmortem examination stones are often found in patients who, during life, never had any gall bladder symptoms, and many stones containing gall bladders reveal no anatomical changes in their walls. This would suggest that mechanical interference as represented by the presence of stones can be considered an aggravating, but not a primary factor in the production of gall bladder lesions.

There is even less support for the theory of mechanical cholecystitis in a gall bladder without stones. Cases of gall bladder disease after external injury are as rare as traumatic appendicitis. The gall bladder is deeply imbedded in the liver and well protected against injuries from the outside, hence cholecystitis on a purely mechanical basis in the stoneless gall bladder cannot be accepted.

In considering the possible chemical agents as etiological factors, there are as many possibilities as there are constituents in bile. Thorough investigation, however, meets with the

TABLE IIIA.—RATIO OF CONCENTRATION

	Liver bile	Gall bladder bile	Ratio of concentration
Hydrogen-ion concentration	6 7 ¹	5 9 ⁶	
Carbon dioxide .	95 5	20 5	0 2 ¹
Chlorine, mgm per cent .	243 6	79 8	0 3 ²
Bile acid, mgm per cent	204 5	719 5	3 6
Phosphorus, mgm per cent	27 5	200 9	7 3
Milliequivalent per liter base	187 5	211 2	1 1
Calcium, mgm per cent .	8 8	24 3	2 8
Magnesium, mgm per cent	Practically none		
Total nitrogen, mgm per cent	178 4	382 7	2 2
Non-protein nitrogen, mgm per cent			
	12 4	43 5	3 5
Protein nitrogen, mgm per cent	166 1	399 1	2 0
Solids, gm per cent	6 6	21 1	3 2

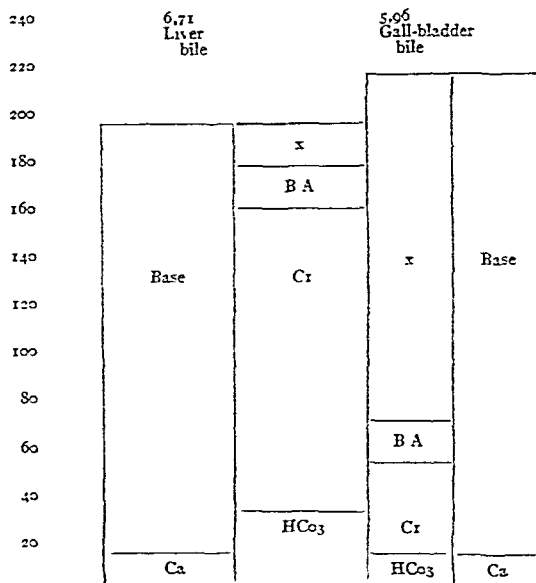
greatest difficulties, since we know very little about the quantitative composition of bile. Elaborate chemical studies of the composition of bile by Ravdin have shown wide variations, the studies of which offer but little hope of drawing definite conclusions. Our own similar chemical studies have likewise defied any logical interpretations. The acidification of bile during its concentration in the gall bladder was first recorded by Okada and later confirmed by several authors. The mechanism, however, by which this process takes place, has never been clearly demonstrated.

We therefore attempted to make parallel analyses of both liver and gall-bladder bile in dogs, estimating the main factors which affect the acid-base equilibrium. Since a number of experiments indicated that different anesthetics and drugs affect the quality of the bile, special precautions were taken in obtaining the bile.

First, we performed a laminectomy in the middorsal region under local anesthesia and transected the spinal cord. About 1 hour later when the dog had recovered from the shock, the abdomen was opened, the cystic duct clamped, and a glass cannula inserted into the common duct. This cannula was connected with a rubber tube leading to a glass container in which the bile was collected under oil. The carbon dioxide and hydrogen-ion concentration values were determined immediately.

Standard methods for blood and urine were used for the bile analyses, which were rendered difficult because of the mucus and color content. Tables IIIA and IIIB show the average

TABLE III B



Anions and cations in M eq/L

results of the analyses of 7 liver and 12 gall-bladder biles of other dogs electrocuted. It is obvious from the study of these charts that our analyses as well as those of previous workers fail to explain entirely the acidification of the bile in the gall bladder. It is quite surprising to note that in spite of the acidification there is a rapid absorption of calcium and carbon dioxide ions. The only acid which seems to increase to any extent is the phosphate and even this, as is shown on the table, accounts for only part of the change. The \times anion of Ravdin remains a mystery.

NITROGEN CONTENT OF THE BILE OF NORMAL AND DISEASED GALL BLADDERS

Since the total nitrogen in bile seems to maintain a fairly constant level, deviations from this level might be of importance for understanding the pathology of this organ. Pathological processes in the gall-bladder wall might merely be associated with changes in nitrogen content of the bile, or these changes might be the primary cause for gall-bladder reactions.

Little work has been done on the nitrogen content of bile. Gunderman found that the

TABLE III—MISCELLANEOUS BACTERIA*

Experiment No	Bacteria injected	Amount in c. cm	Method of introduction	Duct open except where ligation stated	Complications and results
1	<i>Staphylococcus albus</i>	1	Catheter	Cannula	Gall bladder normal
2	<i>Staphylococcus albus</i>	1	Needle puncture		Gall bladder normal
3	<i>Staphylococcus albus</i>	1	Needle puncture	Cystic duct ligation	Transmural no slight reaction on gall bladder
4	<i>Staphylococcus aureus</i>	1	Catheter	Cannula	Gall bladder normal
5	<i>Staphylococcus aureus</i>	1	Catheter	Cannula	Gall bladder about normal
6	<i>Staphylococcus aureus</i>	1	Catheter	Cannula	Gall bladder normal
7	<i>Staphylococcus aureus</i>	1	Catheter	Cannula	Bile peritonitis some reaction on gall bladder
8	<i>Staphylococcus aureus</i>	1	Needle puncture		Slight reaction on gall bladder
9	<i>Staphylococcus aureus</i>	1	Catheter	Common duct ligation	Died Cholecystitis 3 postmortem changes
10	<i>Streptococcus viridans</i>	1	Catheter	Cannula	Gall bladder about normal
11	<i>Streptococcus viridans</i>	1	Catheter	Cannula	Gall bladder normal some bile peritonitis
12	<i>Streptococcus viridans</i>	1	Catheter	Cannula	Gall bladder normal
13	<i>Bacillus welchii</i>	1	Catheter	Cannula	Gall bladder normal
14	<i>Bacillus welchii</i>	0.5	Catheter	Cannula	Gall bladder normal
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In considering the possible chemical agents as etiological factors, there are as many possibilities as there are constituents in bile. Thorough investigation, however, meets with the

THE TOXIC EFFECT OF BILE

Having obtained marked reactions in the gall bladder of dogs after the injection of foreign protein, the next procedure in our studies was to examine the constituents of bile itself for any possible toxic effect.

Bile as a whole cannot be considered toxic to the gall-bladder wall if present in normal concentration. As seen from our control experiments, removal of bile from a dog's gall bladder by means of a catheter and replacing it by bile from another dog leaves the gall-bladder wall unchanged. Similarly ox bile introduced into the dog's gall bladder gives negative results.

It has long been known, however, that bile has a marked toxic effect outside of the gall bladder, a subject upon which a large amount of literature has been written. The local destructive power of bile in contact with living tissue has been demonstrated repeatedly. Flexner, and Meltzer and Salant showed that bile causes necrosis of living cells and hemolysis of blood cells. Pancreatic necrosis has been produced by many authors with gall-bladder bile. Dragstedt (17) demonstrated an acute necrosis of the pancreas which had been brought in contact with bile through a window in the gall-bladder wall. Necrosis of muscle and subcutaneous tissue results from the injection of sterile bile or a solution of bile salts, as demonstrated by Andrews in the experimental animal. Similarly, lesions in the stomach wall and in the salivary glands have been produced by Sellards.

Flexner demonstrated that it is bile salts which constitute the toxic element in bile, and expressed the opinion that gall-bladder bile, in which bile salts are relatively concentrated, is more toxic than liver bile.

In addition to the local toxic effect, there is a well known systemic toxic action of bile. Many investigators have found that animals die within a short period of time from intravenous injection of bile or bile salts. Dragstedt (18) demonstrated that animals died within 2 or 3 days when the common bile duct was anastomosed to the vena cava or portal vein. In discussing the toxic action of bile and bile salts, we ought to mention briefly a mechanism which is supposed to compensate

TABLE IV—NITROGEN CONTENT OF BILE*

	No	mgm Total N	Average	Prot N	Average	NPN	Average	Prot P	Average
Stone containing	1	426 0		150 0				13.2	
	2	315 0		150 0		162 0			
	3	577 0	496.2	170 5	118.2	375 0	326.5	34.4	20.3
	4	577 0		93 8		442 5		13.8	
	5	498 0		114 0		330 0			
Chronic changes on the gall- bladder wall (adhesions, hypertrophy, obliteration, etc.)	6			45 6		37 4		11.8	
	7			75 0		70 0			
	8	55 0		45 0				10 0	
	9			120 0				31.4	
	10	353 0		120 0				20 0	
	11	543 0		384 0				20 0	
	12	555 0		320 0				36.2	
	13	924 0		462 0		444 0		37 0	
	14	200 0		40 0		143 0		12.2	
	15	387 0		166 5		199 5		24.6	
	16	273 0	129	78.2	174.9	207 0	167.7	25.6	21.3
	17	666 0		366 0		285 0		28.4	
	18	327 0		130 5		171 0		13.3	
	19	568 0		250 5		250 5		25 0	
	20	493 7		156 5		313 0		20 0	
	21	375 0		156 5		221.3		18.6	
Normal and distended gall bladder	22	354 0		125.2		222 0		21.3	
	23	354 0		136 0		180 0		9.5	
	24	480 0		181.5		300 0		16.9	
	25	300 0		115.5		177 0		20.6	
	26	310 0		187 0		300 0		25 0	
	27	62 0		43.1		12.5		11.4	
	28	770 0		375 0				47 0	
	29	476 0		125 0				16.1	
	30	706 0		300 0				13.2	
	31	750 0		210 0				12.9	
	32	266 0		94 0		166 0		20 0	
	33	300 0		199.5		78 0		26.6	
	34	555 0	441	250 0	168.3	300 0	152.8	27.8	21.6
	35	240 0		65.2		177 0		15.4	
	36	177 0		49.8		123 0		11.8	
	37	354 0		81.7		271 0		12.5	
	38	261 0		93.7		125 0		19 0	
	39	798 0		177 0		600 0		23.1	
	40	600 0		354 0		231 0		48.4	
	41	300 0		77 0		207 0		19 0	

*Material obtained at postmortem—41 human postmortem bile

nitrogen content in stone containing gall bladders was variable, while it was usually higher in cholecystitis. Boekelman arrived at similar conclusions by aspirating bile from the duodenum in man.

We conducted a series of observations to confirm those conclusions.

First, we examined 41 human gall bladders obtained at postmortem. We tried to make a gross diagnosis of the gall bladders in each instance, using as a basis only the most obvious signs, which were little influenced by postmortem changes. The diagnoses of stones, adhesions, hypertrophy of the wall and obliteration of the cavity could be made with assurance, but we did not try to make any finer diagnoses, or to conduct microscopic examinations in this series, since postmortem changes do not permit such precise study.

In our second series which consisted of 13 fresh specimens obtained at human operations a more definite pathological diagnosis was made. This was confirmed by the clinical history of the patient and by microscopic examination. Fresh bile was available in this series for chemical studies. For the sake of comparison the same classification was applied here as in the postmortem series, the similarity in the results showing that postmortem changes had not influenced the figures of the postmortem bile to a great extent.

In addition, determinations of the protein phosphorus were made using the colorimetric method of Fiske and Subbarow.

A glance at Tables IV and V shows that no definite correlation exists between the nitrogen and phosphorus content of bile and diseases of the gall bladder. While there is no marked difference in the average figures in stone containing normal and chronically diseased gall bladders, there is a great variation in the individual figures of each group. Total nitrogen, for instance, in the group with chronic changes varies from 55 to 924 milligrams per cent.

Animal experimentation yielded similar results. We found in dogs where the common duct was ligated, that the total nitrogen rose in some cases, while it fell in others. The average figure in 8 normal dogs was 340 milligrams per cent.

PROTEIN INJECTION INTO THE GALL BLADDER

We learn from the last series of experiments that no conclusions can be drawn about the pathology of the gall bladder from the nitrogen content of bile.

However, there still remains the question as to whether increase in the nitrogen content can set up a reaction in the gall bladder wall.

We tried to approach the matter experimentally by increasing the nitrogen content and observing the effects. This was done by the rough method of injecting egg albumen into the dog's gall bladder. Six cubic centimeters of undiluted white of egg or 6 cubic centimeters of a 6 per cent solution of crystal line purified egg albumen in Pinger's solution were injected into the gall bladder cavity of the dog either by means of needle puncture or with the catheter technique. In some experiments the material was injected into the wall of the gall bladder at 6 or 8 different points. Where the material was introduced into the gall bladder cavity, the gall bladder was usually allowed to remain patent, but in some instances the common or cystic duct was ligated.

Fifteen dogs were operated upon none of which died or showed clinical signs of severe illness as a result of the injections. However, when the dogs were electrocuted 48 hours after the operation 13 of the 15 gall bladders showed active recent inflammation. No difference in reaction was found regardless of which technique had been used.

The reaction was characterized by edema, hemorrhage and a fibrinous exudate. Histologically, the most constant finding was edematous thickening of the serosa with round cell infiltration and dilatation of the lymphatics. Fibrinous deposits over the serosa were a frequent finding.

We can rule out traumatization as a cause for this reaction since the same results were obtained on the free surface of the gall bladder when the injection was made through the liver surface or when the material had been introduced through a catheter.

We can say in summary that egg albumen introduced into the wall or cavity of the dog's gall bladder by various techniques almost regularly sets up a reaction in the gall bladder wall.

salts were somewhat stronger than those with commercial bile salts, suggesting that the protein of the latter preparation had exerted a slight protective action against the toxicity. This possible protective action of bile protein will be discussed in more detail in later experiments.

To elucidate still further the toxic action of bile salts, we conducted a more thorough investigation by making use of different bile salt fractions.

Table VI shows the results obtained from the injections in 71 experiments.

For the sake of comparison the 16 experiments using commercial and purified bile salts discussed, have been included in this table. The groups are arranged in the order of decreasing toxicity.

We find that the bile salt mixtures are not the most effective preparations, but that the most severe reactions are obtained with isolated fractions, as desoxycholic, apocholic, and cholic acid which often cause gangrene of the gall bladder and death of the animal. Sodium desoxycholate proved to be the most powerful fraction and in a concentration as low as 7.5 per cent gave a marked reaction. Positive results were obtained with 7 per cent apocholic acid, while higher concentrations were necessary to produce similar changes with cholic acid.

Severe cholecystitis resulted from the injection of concentrated dog bile, which was obtained by evaporation of dog bile by means of a fan to about $\frac{1}{3}$ of its volume and which is known to contain mainly taurocholic acid.

The effectiveness of bile salts is increased rather than decreased by the process of hydrolysis, which consists of alcohol precipitation of the bile salts, sodium hydroxide extraction, precipitation with hydrochloric acid and finally dissolving them with alcohol and sodium hydroxide. We obtained marked reactions with an 8.7 per cent solution and very severe changes, often accompanied by death, with a 20 per cent solution.

Glycocholic acid, on the other hand, proved to be much less effective and produced changes in the gall-bladder wall only in higher concentrations. A study of decholin (dehydrocholic acid) which is used in the medical

TABLE VI—RELATIVE TOXICITY OF DIFFERENT BILE SALTS

Fraction and concentration used	Number of experiments	Final concentration in gall bladder %	Reaction
1. Desoxycholic acid 8 to 13%	13	7.5 to 13	Severe reaction. Gangrene of gall bladder, bile peritonitis, and death
2. Apocholic and cholic acid 7 to 12%	17	7.4 to 11.2	Same
3. Concentrated dog bile (mostly taurocholic acid)	4		Severe cholecystitis, bile peritonitis, and death
4. Hydrolyzed bile salts 10 to 20%	6	8.75 to 20	Severe cholecystitis and death
5. Purified bile salts 10 to 20%	4	8.7 to 15	Same
6. Commercial bile salts 10 to 20%	12	8.5 to 20	No death. Bile peritonitis and cholecystitis
7. Glycocholic acid 8 to 13%	9	7.5 to 11.1	Cholecystitis—occasionally on high concentration, mostly normal gall bladder
8. Decholin (dehydrocholic acid) 20%	6	9.4 to 15	Normal gall bladder

The final concentration of bile salts in the gall bladder in each experiment was calculated in the following manner:

The size of the gall bladder was estimated according to the weight of the dog and the gall bladder in the starving dog considered to be nearly well filled with bile. The bile salt concentration of normal gall-bladder bile in the dog was thought to be 7.5 per cent.

management of human cholecystitis, was added for the sake of completeness. No appreciable reaction is obtained with any concentration.

The gross and microscopic changes in most of these gall bladders are similar to those described in the commercial bile salt group. We might add the frequent occurrence of bile peritonitis, the pathogenesis of which is still only little understood. Bile peritonitis, either localized around the gall bladder or in a diffuse form was often seen without visible perforation of the gall bladder or bile ducts.

No qualitative differences were found in the appearance of the gall bladders after injection of the various fractions, the only differences being quantitative, with the exception of the desoxycholic group. In these cases apparently all of the layers were involved, leucocytic infiltration and hyperemia being found in the mucous membrane and the muscular layer as well as in the serosa. Whether this was due to a direct action of the desoxycholic acid on

TABLE V --NITROGEN CONTENT OF BILE*

	No	Mgm of total nitrogen	Mgm of protein nitrogen	Mgm of non-pro- tein nitrogen
Gall bladder bile	1		527.4	
Stone-containing bile	2		28.0	
Acute change (round cell infiltration edema etc.)	3	24	10.7	
	4	207	111.0	88.0
	5		37.5	
	6	75	34.1	41.6
Chronic change (hyper- trophic processes fibrous thickening etc.)	7		practically none	
	8	285	136.3	125.2
	9	251	115.0	125.0
	10	2.2	30.9	
About normal (very little cell reaction) dis- tended gall bladder	11	152	55.0	
	12	414	22.0	157.0
Live bile	13	44	12.0	28.0

*Material obtained at operation—13 human operation biles

for this toxic effect and which is said to be present in bile proteins

In a study of the hemolytic action of bile *in vitro*, Bayer found that serum protein exerts an inhibitory effect on this process while egg albumen has no such effect. These observations were controlled and confirmed by Sellards who demonstrated that these protective elements were present in serum even in high dilutions. Sellards as well as many other investigators claimed that this protective action of serum against the toxicity of bile plays an important part in acute hemorrhagic pancreatitis. This hemorrhage often found in necrosis of the pancreas, presumably tends to neutralize the action of the bile.

Similar protective action was attributed to mucus and other colloidal substances present in bile itself by Flexner, who assumed that bile protein diminishes the toxic action of bile if brought in contact with pancreatic tissue.

TOXIC EFFECT OF BILE IN THE GALL BLADDER WALL

It has been suggested recently by Andrews that bile may, under certain circumstances, acquire a destructive power in the gall bladder wall, in a manner similar to gastric juice in the stomach and pancreatic juice in the pancreas. The most obvious constituent of bile

which has a toxic and destructive effect on body tissues is the bile salts, which are present in gall bladder bile in rather high concentrations. Figures of 7 or 8 per cent are frequently found while the textbooks of Hawk and Hammersten give the normal concentration at about 10 per cent.

Whatever the normal concentration of bile salts in bile is, we attempted experimentally to increase the bile salt concentration in bile and to observe the effects of this on the gall bladder wall. The results were striking inasmuch as the reactions obtained in the gall bladder wall resembled human cholecystitis more closely than any reaction ever obtained previously.

Two forms of bile salts were used, commercial bile salts¹, and the same material freed by alcohol extraction from the large percentage of non alcohol soluble substances which it contains. The injections were all made by means of the non traumatizing technique.

The result of these injections was the production of acute cholecystitis with all the features of human cholecystitis. There was marked enlargement of the gall bladder with the cystic duct obviously shut by swelling of the mucous membrane. The color of the gall bladder was either grayish white or reddish, the serosa being covered with thick fibrous membranes, which in many instances caused the adjacent viscera to adhere to the gall bladder. The gall bladder wall was thickened up to 7 or 8 millimeters and was rigid in character. On microscopic examination the reaction was most marked in the serosa, which was 8 to 10 times its normal thickness and moderately infiltrated with round cells. There were marked hyperemia and punctate hemorrhages along with dilatation of the lymphatics.

A fibrinous exudate was found on the serosa and a slight leucocytic infiltration in certain places. The muscularis was moderately edematous and contained a considerable number of large and small mononuclear cells, with very few polymorphonuclear leucocytes. The mucosa in most instances was practically normal.

The reactions obtained with purified bile

salts were somewhat stronger than those with commercial bile salts, suggesting that the protein of the latter preparation had exerted a slight protective action against the toxicity. This possible protective action of bile protein will be discussed in more detail in later experiments.

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the mucous membrane or to secondary involvement of the inner layers from the serosa, cannot be determined from the anatomical picture

IS BILE PROTEIN PROTECTIVE AGAINST THE TOXIC ACTION OF BILE SALTS?

Protein is said to have an inhibitory influence on the toxic action of bile salts, as aforementioned

In relation to our present work it is of special interest to determine whether such a protective mechanism is actually present in the mucus and protein of bile as claimed by Flexner and others. If this theory is correct, bile, deprived of its protein is thus converted into a toxic substance.

In regard to this point the following set of experiments was carried out:

Ox or dog bile was deproteinized either by boiling for 5 minutes and filtering or else by autoclaving for 15 minutes at 15 pounds and filtering. This was then injected into a dog's gall bladder in 13 experiments. In 9 instances in which this bile had been introduced by means of the catheter cannula technique normal or practically normal gall bladders were obtained. Two of 4 cases however in which the material had been introduced by means of needle puncture and followed by duct ligation, showed a severe reaction apparently due to the duct ligation. We might thus conclude that removal of the protein does not convert bile into a toxic substance.

STUDY OF THE TOXIC EFFECT OF BILE SALTS

From the previous studies it is seen that normal bile, which has a toxic action on tissues outside of the gall bladder is not toxic for the gall bladder wall itself if present in normal concentration even if it is deprived of its protein. An increase in concentration, however, converts the bile into a substance which is highly toxic to the gall bladder wall.

At this point we might inquire as to what extent bile has to be concentrated to bring about this reaction.

Possible means of concentrating the bile are as follows: (1) adding bile salts to whole gall bladder bile, (2) concentrating the dog's own bile within the gall bladder, (3) replacing

the gall bladder bile with another animal's bile which has been concentrated previous to the introduction.

The first method has been widely applied in studying the relative toxicity of various bile salt fractions. It is less useful for a quantitative analysis of the toxic action, in so far as the degree of concentration in the gall bladder to which the bile salts have been added is an unknown factor.

The concentration of the dog's own bile, without removal from the gall bladder, would be the ideal method. However such attempts have met with great difficulties. Since all water absorbing chemicals damage the gall bladder wall severely, we tried to accomplish this concentration by washing the gall bladder bile with dry, warm air for a certain length of time. Increase in the concentration of solids accompanied by a slight reaction in the gall bladder wall was obtained in some instances. However, the number of positive results and the degree of reactions obtained are too small from which to draw any conclusions.

More satisfactory results were obtained from the third method mentioned, namely, the replacement of gall bladder bile by bile concentrated previous to its introduction. Since the gall bladder was emptied before we introduced the known material, we excluded fairly well known factors in the analysis.

The bile, used for the experiments, was concentrated in the following manner:

Dishes each containing 200 cubic centimeters of fresh ox bile, were exposed to an electrical fan for varying periods of time, allowing evaporation and concentration down to 150, 110, 88, and 60 cubic centimeters. These different biles were injected by the catheter method into the dog's gall bladder, which was emptied previously by aspirating the entire bile content.

Table VII gives the results of these experiments and needs little additional comment. Concentration of ox bile to about half its volume has marked local and systemic effects in the dog while death frequently occurs from stronger concentrations.

To prove that the changes obtained were actually due to the toxic action of concentrated bile and not to accompanying bacterial

TABLE VII.—EFFECT OF VARIOUS CONCENTRATIONS OF OX BILE ON DOG'S GALL BLADDER

Ox bile	No of experiments	Results
Plain	3	Gall bladder practically normal in all instances
Concentrated 150	5	Gall bladder normal in 2 cases, slight reaction in 3 cases
Concentrated 110	6	Moderate degree of cholecystitis, 2 cases; moderate degree of cholecystitis plus bile peritonitis, 2 cases; severe cholecystitis, 2 cases
Concentrated 88	6	Severe cholecystitis, 1 case; severe cholecystitis plus bile peritonitis, 1 case; death and severe reaction, 4 cases
Concentrated 60	4	Severe cholecystitis, 1 case; severe cholecystitis plus bile peritonitis, 1 case; death plus severe reaction, 2 cases

infection, the following experiments were undertaken.

Since bacterial cultures revealed that the biles which had been exposed to air for any considerable time contained a great number of bacteria, we rediluted these concentrated biles to their original volumes and injected them into the dog's gall bladder.

No reaction was obtained, as seen from Table VIII, which proves that bacterial infection is not the cause of the changes obtained in the gall bladders.

EFFECT OF VARYING HYDROGEN-ION CONCENTRATION ON THE TOXICITY OF BILE SALTS FOR THE NORMAL GALL BLADDER

In subjecting the preceding findings to thorough criticism, there is still the possibility that the reactions produced might have been due to a change in the hydrogen-ion concentration of gall bladder bile. This change in hydrogen-ion concentration might convert the bile into a toxic substance. There are 2 ways of controlling this factor.

One method would be to produce a change in the hydrogen-ion concentration of gall bladder bile in the experimental animal by adding acid or alkali and observing the effect. The other method consists of the introduction of bile salt solution previously adjusted to the hydrogen-ion concentration of gall-bladder bile. Both methods have been applied.

The first method clearly demonstrates the

TABLE VIII.—CONTROL EXPERIMENTS WITH CONCENTRATED AND REDILUTED OX BILE

Ox bile	No of experiments	Results
Concentrated 150, rediluted	2	Gall bladder normal
Concentrated 110, rediluted	2	Gall bladder normal
Concentrated 88, rediluted	2	Normal, 1 case, slight reaction, 1 case
Concentrated 60, rediluted	2	Gall bladder normal

marked buffering action of bile. Injection of 5 cubic centimeters of glacial acetic acid into the dog's gall bladder was followed by total gangrene of the gall bladder and death of the animal. The hydrogen-ion concentration after adding this acid to the gall-bladder bile and thoroughly mixing, was about 2. Similarly, total gangrene of the gall bladder resulted from adding 10 cubic centimeters of 20 per cent sodium carbonate to the gall-bladder bile with a final hydrogen-ion concentration of 10.

More detailed information concerning the buffering potentialities of bile is yielded from the following experiments:

After aspiration of the total gall-bladder bile, the gall bladder was washed with a citric-phosphate buffer solution and was left filled with this solution. When the animals were electrocuted 48 hours later no changes in the gall-bladder wall were found. In other experiments, the same procedure was performed, a citric-phosphate solution of hydrogen-ion concentration of 3 being used. In one of these cases the gall bladder, containing a thin colorless fluid, showed a moderate degree of acute cholecystitis, but in the other it was refilled with dark bile and revealed a normal wall. It is obvious that the bile, which had re-entered the gall bladder through the hepatic ducts, by its buffering action, had kept the acid mixture from developing an irritating action on the wall of the gall bladder.

Various difficulties were encountered in performing the second series of experiments, namely, the introduction into the gall bladder of bile salts previously adjusted to the hydrogen-ion concentration of gall-bladder bile. In the first place, bile salts are easily pre-

TABLE IX—EFFECT OF VARYING HYDROGEN ION CONCENTRATION ON TOXIC EFFECT OF BILE SALTS ON THE NORMAL GALL BLADDER

Injected solution	Hydrogen ion concentration	Result
1 Sodium desoxychol 10%	pH after adjust with 0.1 mol citric acid 7.5	Severe cholecystitis
2 Sodium desoxychol 9%	7.5	Severe cholecystitis
3 Cholic acid 1 60%	7.8	Mild cholecystitis
4 Cholic acid 5%	7.4	Mild cholecystitis
5 Purified bile salts 15%	pH without adjust, 5.7	Moderate cholecystitis
6 Purified bile salts 15%	5.7	Moderate cholecystitis
7 Citric acid NaOH	1 M citric acid adjust with NaOH to 7.0	Normal gall bladder
8 Citric acid NaOH	7.4	Normal gall bladder

precipitated by adding acid to a bile salt solution. Furthermore, we have to consider that many acids, if brought in contact with the gall bladder wall themselves set up a reaction. We were able to overcome these difficulties by the use of a weak citric acid solution which as seen from controls, would not cause any change in the gall bladder wall even in a concentration higher than that used. As an example, the adjusting procedure for sodium desoxycholate is given as follows: 12 grams of sodium desoxycholate are dissolved in 100 cubic centimeters of distilled water. This solution which has a hydrogen ion concentration of 8.4 is heated to body temperature and 0.1 mol citric acid added one drop at a time. The precipitate which occurs is dissolved by shaking. After approximately the desired hydrogen ion concentration is reached (determined first roughly by a set of indicators) more exact determination is done with Hastings colorimeter. Table IX shows the results of experiments with adjusted bile salts, and the controls with citric acid. It is seen that the toxic effect of bile salts on the gall bladder wall is not changed when the hydrogen ion concentration is adjusted to that of gall bladder bile previous to injection. Citric acid solution, furthermore in concentrations even higher than that used for the adjustment does not in itself affect the gall bladder wall.

ALLERGIC GALL BLADDER REACTION

It is suggested by clinical observations that a reaction may occur in the biliary system in man which is based on an anaphylactoid condition. Many surgeons have seen flare ups of old gall bladder disease apparently due to an anaphylactic response against certain food stuffs such as chicken, egg, milk, cheese etc., omission of these foods affording relief. Alvarez and more recently Crouch reported several cases of this kind. The anaphylactic nature of this process, however, has only been suspected and no experimental proof has ever been given.

Hence the following experimental observations may be in place:

Each of 3 dogs received intravenous injections of crystallized egg albumen within a period of 3 days, each injection consisting of 5 cubic centimeters of a 6 per cent solution. No reactions were observed either during or after these injections. After an interval of 6 days similar injections of a 6 per cent solution of the same material were made, but this time in much larger quantities sufficient to produce visible toxic symptoms. In 2 of the animals the reaction consisted of vomiting, trembling, irregular respiration and passage of feces while in the third the response was much more pronounced, consisting of vomiting, loss of consciousness, cessation of respiration for 3 minutes and generalized convulsions. The quantity of the last injection was 15 to 20 cubic centimeters in the first 2 dogs and 25 cubic centimeters in the third. The animals were electrocuted $\frac{1}{2}$ hour following the last injection and postmortem examinations were made immediately. In all 3 cases there was found marked edema of the gall bladder wall, most marked in the serosa. Microscopic examination of the liver showed markedly constricted arterioles.

As a control egg albumen was injected in large amounts into 3 other dogs which had not received any previous injections. In 2 of these animals no symptoms were visible until 40 cubic centimeters had been injected. After 45 cubic centimeters however the reaction was marked but consisted only of vomiting and passage of feces. In the third dog the symptoms did not appear until 60 cubic centimeters

meters had been injected. Postmortem examination after electrocution revealed perfectly normal gall bladders.

A comparison of the results in the 2 series of animals suggests the conclusion that the reaction obtained after the last injection in the first series was an anaphylactic response, since it required much less albumen to produce a response in the previously sensitized dogs than in the control animals. Furthermore, the constriction of the arterioles in the liver in the first series of animals is suggestive of anaphylactic change.

BILE SALT INTRAVENOUS INJECTIONS

It is of great interest for the understanding of gall-bladder symptoms in man that it is possible to produce a condition of anaphylaxis experimentally.

Such an allergy might explain the gall-bladder symptoms which occur after the intake of certain foods. When we consider the frequency of gall-bladder disease, however, as contrasted to the comparatively rare observation of food allergy, we are inclined to believe that allergy, caused by exogenous food substances, is not of great practical importance.

Many possibilities present themselves, however, when we consider endogenous body substances. Many metabolic products may serve as sources of allergic states as well as any disturbance in the detoxifying action of the liver cells.

This consideration becomes of much more practical importance in view of experimental results which we obtained.

Having seen the powerful toxic action of bile salts in the gall-bladder wall, at a concentration which exceeds only slightly the normal values, we were tempted to suspect that an anaphylactic mechanism might be responsible for these effects.

The results which we obtained are striking, but since these studies are not as yet completed, we are not reporting the detailed work. We do not obtain positive results with such regularity that we can predict the conditions under which they will occur. There are still many factors the nature of which are unknown to us.

There follows a rough outline of the experiments:

Intravenous injections of commercial bile salts, purified bile salts or sodium desoxycholate were given to 26 dogs, concentrations of 5 or 10 per cent being used.

The number of injections given to each animal as well as the total amount injected varied considerably in the different experiments.

In one series we gave single injections, which we discontinued after toxic symptoms, such as vomiting, convulsions, etc., became visible. This stage was reached in our animals which had an average weight of 5 to 6 kilograms after 25 to 30 cubic centimeters of the 5 per cent solution had been injected. Those animals which did not die spontaneously, were electrocuted a few minutes after the injection.

Another group of dogs received 2 injections each, 20 minutes apart. We carefully avoided getting a marked toxic effect from the first injection, while the amount administered in the second injection was large enough to produce visible toxic signs or death of the animal.

A third group received 4 to 5 injections at hourly intervals, beginning with a comparatively small amount (10 to 12 c cm.) in the first injection and ending with 15 to 40 cubic centimeters in the last one. The last group received daily injections for about a week, and these animals were killed a few days after the last injection.

These experiments resulted in marked reaction of the gall-bladder wall in more than half of the cases, the positive results being found in the first 3 groups, while the fourth was completely negative.

No definite correlation, however, can be made between the different methods of administering the bile salts in the different groups and the reactions obtained. The number of positive results was greater in the first and second groups, where the 1 or 2 injections had been given within 3 to 20 minutes, than it was in the third. In the latter group the injections had extended over several hours.

The shortest time in which a reaction occurred was 3 minutes. Purified bile salts

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5 Purified bile salts 15 4%	pH without adjust. 5.5	Moderate cholecystitis
6 Purified bile salts 15 4%	5.7	Mild rate cholecystitis
7 Citric acid NaOH 1 M citric acid adjust with NaOH 10% 7		Normal gall bladder
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precipitated by adding acid to a bile salt solution. Furthermore, we have to consider that many acids, if brought in contact with the gall bladder wall themselves set up a reaction. We were able to overcome these difficulties by the use of a weak citric acid solution, which, as seen from controls would not cause any change in the gall bladder wall even in a concentration higher than that used. As an example, the adjusting procedure for sodium desoxycholate is given as follows: 12 grams of sodium desoxycholate are dissolved in 100 cubic centimeters of distilled water. This solution, which has a hydrogen ion concentration of 8.4, is heated to body temperature and 0.1 mol citric acid added one drop at a time. The precipitate which occurs is dissolved by shaking. After approximately the desired hydrogen ion concentration is reached (determined first roughly by a set of indicators) more exact determination is done with Hastings colorimeter. Table IX shows the results of experiments with adjusted bile salts, and the controls with citric acid. It is seen that the toxic effect of bile salts on the gall bladder wall is not changed when the hydrogen ion concentration is adjusted to that of gall bladder bile previous to injection. Citric acid solution furthermore in concentrations even higher than that used for the adjustment does not in itself affect the gall bladder wall.

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Hence the following experimental observations may be in place:

Each of 3 dogs received intravenous injections of crystallized egg albumen within a period of 3 days each injection consisting of 5 cubic centimeters of a 6 per cent solution. No reactions were observed either during or after these injections. After an interval of 6 days similar injections of a 6 per cent solution of the same material were made but this time in much larger quantities sufficient to produce visible toxic symptoms. In 2 of the animals the reaction consisted of vomiting, trembling, irregular respiration and passage of feces while in the third the response was much more pronounced consisting of vomiting, loss of consciousness, cessation of respiration for 3 minutes and generalized convulsions. The quantity of the last injection was 15 to 20 cubic centimeters in the first 2 dogs and 25 cubic centimeters in the third. The animals were electrocuted 1½ hour following the last injection and postmortem examinations were made immediately. In all 3 cases there was found marked edema of the gall bladder wall most marked in the serosa. Microscopic examination of the liver showed markedly constricted arterioles.

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human operations shows that there is no definite correlation between the nitrogen content of the bile and the changes of the gall-bladder wall, the fluctuations in nitrogen content being extreme in both

5 Injections of egg albumen into the dog's gall bladder set up an active acute inflammation

6. Changes of the gall-bladder wall of the dog which on gross and microscopic examination closely resemble those found in human cholecystitis, were produced in 72 experiments by the injection of bile salts. The differences in the activity of different fractions of bile are mainly quantitative in nature. Desoxycholic acid is the most effective fraction, causing gangrene of the gall bladder and death of the animal in many instances, while purified and hydrolyzed bile salts are somewhat weaker. Glycocholic acid causes a marked reaction only in higher concentration.

7 Injection of deproteinized dog or ox bile into the dog's gall bladder leaves the gall-bladder wall unchanged. No protective action of protein, as described in the literature, can be found.

8 A quantitative study of the toxic effect of bile salts was made by replacing gall-bladder bile in the dog by bile concentrated previous to the injection. Bile concentrated to about half its volume proved to have a marked effect.

9 Changes in the hydrogen-ion concentration of bile rarely bring about a reaction in the gall-bladder wall unless they are extreme, less than 3 and greater than 10. Such changes are not likely to arise in man. The toxic effect of bile salts is not due to a change in hydrogen-ion concentration since adjustment of the bile salts to the hydrogen-ion concentration of the gall-bladder bile previous to the introduction, did not diminish their toxic effect.

10 It is possible to produce experimentally an allergic condition in the gall bladder. Intravenous injection of egg albumen caused an edema in the gall-bladder wall of previously sensitized dogs, while no reaction occurred in control animals

11. A marked edema of the gall-bladder wall was produced by the intravenous injection of bile salts. The shortest time in

which this reaction took place was 3 minutes after the injection

It has been suggested that a temporary increase in bile salt concentration in the gall bladder brings about human cholecystitis.

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seem to be more effective than any other fractions

Postmortem examination revealed a grayish white gall bladder with congestion of the serosa. Edema, most marked on the liver surface, was a prominent feature. No changes were found anywhere else in the body. Microscopic examination showed the serosa to be edematous, and swollen to 6 times its normal thickness.

EVALUATION OF STUDY

The gall bladder contains the strongest solution of any substance which the human body elaborates and this substance (bile acids) is an exceedingly toxic one. The normal gall bladder is a concentrating mechanism of high potency and our experiments show that only a slight overaction of its every day action may produce a concentration whose effect is damaging to the gall bladder and the surrounding tissues. This effect might be brought about in three different ways. First by the gall bladder itself from simple overaction, or second by the excretion of bile by the liver which is too concentrated in the first place, or third by the excretion of bile by the liver which contains substances which might become toxic on further concentration.

The first of these theories seems the least probable. The range of the normal liver bile in bile acid content is a wide one. The amounts may be very small but the gall bladder seems to tend to absorb water and to concentrate them all to about the same level. It has been shown in previous communications that the normal gall bladder in the course of its concentrating action absorbs but little bile salts during the period between emptyings but that if the action is prolonged, by stasis eventually all the bile salts will be absorbed. Such an action has been shown to be capable of precipitating the cholesterol in the bile which needs the bile salts to hold them in solution. This process apparently takes place without the patient going through an attack of cholecystitis, as the many specimens of such gall bladders show taken from individuals who have never had such an attack.

The second alternative, an increased secretion from the liver, also seems improbable,

as if such were the case values within the toxic range would certainly have been reported previously by some of the many who have worked in this field.

The third theory, a qualitative difference in the bile salts excreted by the liver, cannot be so easily disposed of. Our experiments indicate a far higher degree of toxicity for some of the unconjugated bile acids. We have previously reported the findings of large amounts of such bile acids in the liver bile of a diabetic, and it seems not unlikely that such may not be an uncommon occurrence. The present limitations of bile salt chemistry make it impossible to recognize even large amounts of such materials in the amount of bile recoverable from a gall bladder, but one may hope that progress in this field may soon make such analyses possible.

If some such theory of the origin of some cases of gall bladder disease is entertained, it fits in well with many of the observed facts which are thought by some to militate against bacterial theories. The frequent afebrile cases, failure to grow organisms in many cases, the pathological picture which Denton describes as resembling a hemorrhagic infarct are all consonant with such a chemical mechanism. The low values from bile acids found in most cases of closed acute gall bladders is explained on the assumption that the original high concentration causes an edema which permits the rapid leaking out of the contents by osmosis. Such can actually be seen in our experiments in the staining of the local peritoneum.

SUMMARY

1. A non-traumatic technique for introducing substances into the dog's gall bladder is described.

2. Most strains of bacteria even when injected in overwhelming numbers do not cause cholecystitis. If trauma is added these same strains do cause cholecystitis.

3. Carbon dioxide and chlorine are absorbed rapidly from the normal gall bladder, while phosphorus is excreted but an unknown amount for much of the acidification.

4. Chemical examination of 45 human postmortem biles and 13 biles obtained at

CARCINOMA OF THE RECTUM

A Plea for Group Study and Treatment

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THIS analysis comprises all the cases of carcinoma of the rectum at St. Luke's Hospital, New York City, between the years 1924 and 1935 inclusive, both private and ward patients operated upon only by members of the hospital staff are included. It is important to understand early in the discussion that a comparison of these statistics with those of group clinics and clinics headed by one individual doing the great majority of work is of doubtful value. The reason for this statement will be made later. The general purpose of this paper is to present:

1. An analysis of these cases, with special reference to (a) the number of cases seen, divided into operable for cure cases, and inoperable cases, (b) a division of the operable for cure cases into groups in relation to their follow-up records.

2. A general discussion of the diagnosis, and of the pre-operative and postoperative management of cancer of the rectum, and suggestions for improving the care and the end-results, in general hospitals organized as St. Luke's Hospital.

Classification of these patients as to sex, age, pre-operative length of symptoms, and etiology, will not be given in this paper. This information, while available, corresponds in general to that given in all the recent papers. We have no hitherto unknown methods of diagnosis or new technique to offer. Our experience in very recent years has given us a better understanding of the management of these cases, and the adoption of those methods used in other clinics to shorten the length of operation, to protect the patient against peritonitis, and to improve the operative technique, has met with varying degrees of success.

DIAGNOSIS

Early diagnosis in this condition is the great hope for better therapeutic results. We believe in almost all cases of carcinoma of the anus, rectum, and rectosigmoid, that a proper digital examination will reveal the presence of the growth; this includes an examination, often with the patient in the stooping position and while they are bearing down. The great hope for the early diagnosis of this condition lies in periodic health examinations, including a digital and proctoscopic examination. The general use of the proctoscope will do much to improve the diagnosis and treatment of all rectal conditions. It is a simple procedure, given the proper instruments, a convenient arrangement, and gentleness on part of examiner. A proctoscopic examination should be part of every x-ray examination of the colon.

The question often arises as to how long a growth has been present. We have seen recently, and not included in this group, one patient who was proctoscoped by a competent observer 1 year prior to his admission, with a negative result. A well developed carcinoma within 2 inches of the anus was found at the end of this time.

Biopsy furnishes an accurate diagnosis as to the presence or absence of cancer, with minor exceptions, and should be done whenever possible. A negative diagnosis, however, must be judged together with the clinical findings. Included in this group is the case illustrated of an adenoma of the rectum, but with carcinomatous degeneration in one portion of the growth. Repeated biopsies failed to show carcinoma. Radical resection was performed. The converse is true, and inflammatory lesions, such as chronic ulcerative colitis and amebic dysentery, can be confusing. Every hard, friable, bleeding mass felt with the finger should not be called carcinoma without further examination.

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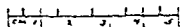
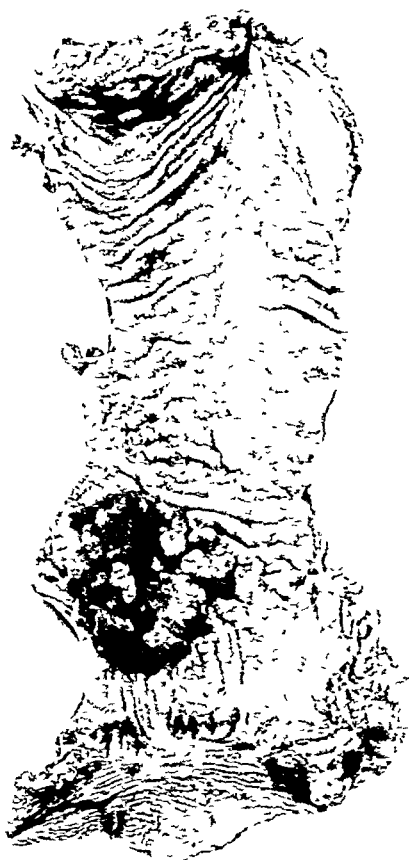


Fig 1 Specimen removed 1 year after a proctoscopic examination by a competent observer, who found abnormality in neither the rectum nor sigmoid.

the gland-bearing area for saving the sphincter. It is hoped additional progress in technique will bring results along this line.

ANESTHESIA

In the last 2 years, the use of spinal anesthesia has been of considerable help to us. With the use of pantocaine up to 2.5 cubic centimeters, introduced between the first and second lumbar vertebrae, we have gotten between 2 and 3 hours of anesthesia, and when the operation has been completed in this time the patients have shown less shock. Cyclo-

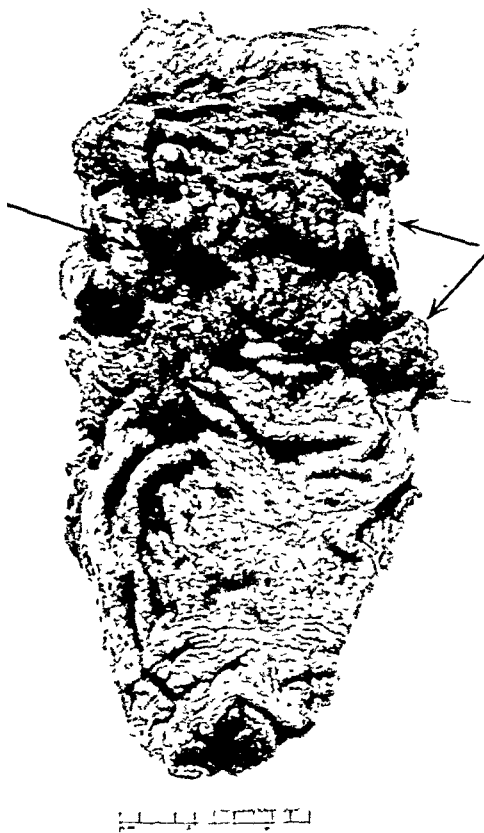


Fig 2 Specimen removed following three biopsy examinations with report of non-malignant adenoma. Carcinomatous degeneration in one portion only. Arrow at left, carcinoma, at right, adenoma.

propane and ether have come into favor when spinal anesthesia is not used. In the great majority of these cases reported the patients were operated upon with open ether anesthesia.

TRANSFUSIONS

We believe that the free use of transfusions before and after operations, regardless of the apparent condition of the patient, leads to fewer complications and a smoother convalescence. This applies to the first as well as the second stage of the multiple stage operation.

OTHER GENERAL CONSIDERATIONS

It has been our own experience in a comparatively small number of cases that the

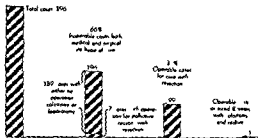


Chart 1 The operability for cure in this series of 190 cases is 34 per cent. In this group this figure is low as compared to 73.6 per cent as reported by Cattell and 53.7 per cent as reported by D. F. Jones of Boston. Operability depends upon two main factors: (a) the class of patient admitted to the clinic. Group clinics depending upon referred patients for the greater number of their cases will have on the whole a better class of patient and an earlier diagnosed lesion than the general hospital in a large city receiving the charity patient from the ambulance in the street. (b) The skill of the operating surgeon. The more experienced the surgeon, the greater the number of cases he will operate upon.

PATHOLOGY

The one hundred cases reported in this series as operable for cure have had microscopic pathological diagnoses. The sections have not been graded according to Broder. Up to this time their relationship to the end results is, therefore, not available. Biopsies were performed in every case of the inoperable group in which a tumor could be reached.

OPERATIVE PROCEDURE

Multiple versus single stage operations. The discussion which is ever present as to whether multiple stage or single stage operations give the best results has been of some interest to



Chart 2 Inoperable cases total 180 from a total of 196. Seven cases with resection without hope for cure are excluded. Deaths following palliative procedures were as follows: 10 died following colostomy, 16 died in the hospital without operation, 5 died in the hospital following laparotomy but without colostomy, no deaths followed cecostomy.

us in examining this series. Fundamental physiological and operative principles should be borne in mind in the choice of operations for these patients, and should include: (a) as short an operation as possible which is consistent with a complete removal of the growth and gland bearing area, (b) the principle of self inoculation against peritonitis.

These two principles find their application in the advocacy of multiple stage procedures. Our own experience does not warrant any specific recommendation in this matter. We believe that any particular set of rules to be followed in every case is not to be accepted.

It has been our impression that the use of the multiple stage operation in the hands of younger surgeons, both as to years and experience, is a far safer maneuver in the majority of cases. To be dogmatic on this point, however, is to lose that fine sensitiveness to the patient's ability to withstand trauma which makes for a good surgeon and a cured and living postoperative patient.

Efforts should be made in judging these patients as to type of operation, to save the sphincter in as many cases as possible. In 8 patients, 2 of whom died, resections were performed saving the sphincter. Seven of these were true rectosigmoid lesions and the great temptation is to remove the growth by the abdominoperineal route. Undoubtedly a number of cases can be saved the inconvenience of a colostomy if experienced surgeons will attempt procedures such as these, but not sacrificing the principle of removing



Chart 3 Included in the 32 postoperative deaths are 4 cases in which only the first stage of a multiple stage procedure was carried out.

The 10 5 year arrests represent 31.5 per cent of 55 resections. Note that the figure at top of column indicates percentage as well as number of cases.

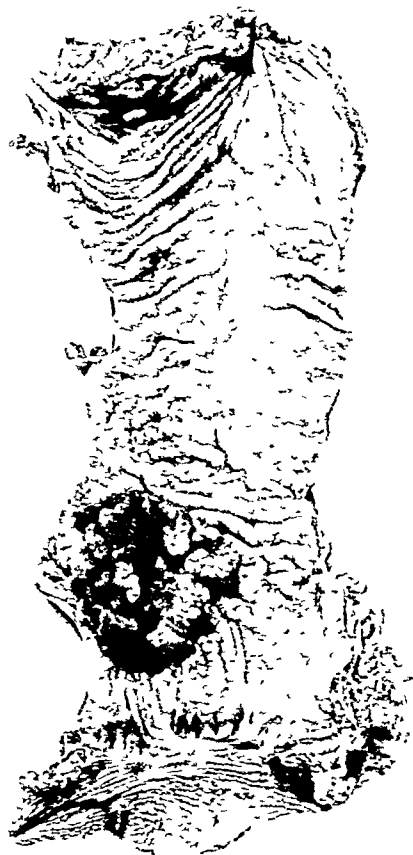


Fig 1 Specimen removed 1 year after a proctoscopic examination by a competent observer, who found abnormality in neither the rectum nor sigmoid

the gland-bearing area for saving the sphincter. It is hoped additional progress in technique will bring results along this line

ANESTHESIA

In the last 2 years, the use of spinal anesthesia has been of considerable help to us. With the use of pantocaine up to 2.5 cubic centimeters, introduced between the first and second lumbar vertebrae, we have gotten between 2 and 3 hours of anesthesia, and when the operation has been completed in this time the patients have shown less shock. Cyclo-



Fig 2 Specimen removed following three biopsy examinations with report of non-malignant adenoma. Carcinomatous degeneration in one portion only. Arrow at left, carcinoma, at right, adenoma

propane and ether have come into favor when spinal anesthesia is not used. In the great majority of these cases reported the patients were operated upon with open ether anesthesia

TRANSFUSIONS

We believe that the free use of transfusions before and after operations, regardless of the apparent condition of the patient, leads to fewer complications and a smoother convalescence. This applies to the first as well as the second stage of the multiple stage operation

OTHER GENERAL CONSIDERATIONS

It has been our own experience in a comparatively small number of cases that the

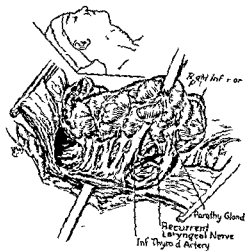


Fig 2



Fig 3

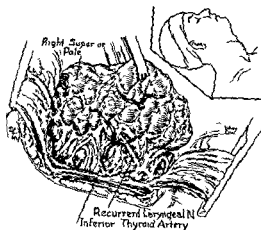


Fig 4

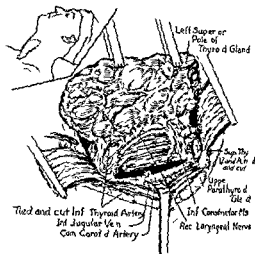


Fig 5

Fig 2 Illustration made at the operating table with the thyroid gland elevated out of its bed and inverted. The inferior thyroid artery is demonstrated and the typical relationship of the recurrent laryngeal nerve to the inferior thyroid artery is shown. Note the relationship of the lower parathyroid gland.

Fig 3 This illustration likewise was made at the operating table. Note that in this case the recurrent laryngeal nerve runs over the lower branch of the inferior thyroid artery and is buried beneath a tongue of thyroid tissue near the upper pole at which level it enters the larynx. Note the typical position of the lower parathyroid gland between the branches of the inferior thyroid; note the upper parathyroid which of all parathyroid glands is the

most constant in location most easily found in its position against the larynx. This thyroid gland has been elevated and inverted.

Fig 4 In this operative dissection the recurrent laryngeal nerve runs beneath both branches of the inferior thyroid artery in its typical relationship.

Fig 5 In this operative dissection as in the others the superior thyroid pole has been freed and cut; the gland has been elevated from its bed and inverted and the inferior thyroid artery has been cut between ties to permit complete exposure of the recurrent laryngeal nerve up to the point at which it enters the larynx. This extent of exposure will rarely be necessary. Note again the constant location of the superior parathyroid gland.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, THE LAHEY CLINIC

ROUTINE DISSECTION AND DEMONSTRATION RECURRENT LARYNGEAL NERVE IN SUBTOTAL THYROIDECTOMY

FRANK H. LAHEY, M D , F A C S , Boston, Massachusetts

UP to the present it has been the custom for surgeons operating upon the thyroid gland to take the position that they do not want to see the recurrent laryngeal nerve, that if the nerve is seen it is endangered, and that as the result of stretching and manipulation consequent to its exposure, recurrent laryngeal paralysis may result. It has been the custom of thyroid surgeons to avoid injury to the recurrent laryngeal nerve by leaving sections of thyroid tissue over the region where the nerve should be and by avoiding in the dissection the region in which the recurrent laryngeal nerve is presumably located. It has frequently been stated also that technical measures directed toward high elevation of the lateral lobes of the thyroid gland out of their beds could so stretch the recurrent laryngeal nerve that paralysis might well occur.

About 3 years ago we instituted the policy of dissecting the recurrent laryngeal nerve in practically every type of thyroid operation. In the year 1935, 998 thyroid operations were done; in the year 1936, 1,148, and during 1937 more than 1,300 thyroid operations have been done. It is obvious that in hundreds of cases the recurrent laryngeal nerve has been palpated while moderately on the stretch, dissected, and so visualized that in each case it could be clearly demonstrated to assistants and visitors. It has been demonstrated and visualized on one side, or on both sides, in patients with exophthalmic goiter, with a recurrent type of goiter, with toxic adenomas, with large and small discrete adenomas, with deep intrathoracic goiters, and in patients with all grades and types of malignancy. In none has there been either immediate or later paralysis or changes in position of, or motion in, the vocal cords as result of these dissections.

As the result of this large experience with the anatomical relationship between the recurrent laryngeal nerve, the inferior thyroid artery, the trachea and the thyroid itself, we are certain that there is a very definite constancy in the location of this nerve, and that this constancy of location

occurs no matter what type of goiter is present, regardless of how large it is or how deep it is situated in the chest. Formerly it was considered that when the intrathoracic goiter had extended deep into the mediastinum there was danger that the downward extension of the intrathoracic masses of thyroid tissue would result in downward pressure and stretching of the recurrent laryngeal nerve. We have now removed several hundred intrathoracic goiters, many of which have extended down to within a rib or two of the level of the diaphragm (Fig. 1). Following these removals we have done dissections and demonstrations of the recurrent laryngeal nerve on the side on which



Fig. 1 The depth of this intrathoracic goiter is outlined by arrows and the degree of tracheal deviation by dashes. If an intrathoracic goiter ever distorts the course of the recurrent laryngeal nerve, in this type of goiter the nerve should be displaced. In a large number of cases similar to this the recurrent laryngeal nerve has been dissected and found to be in the normal position.

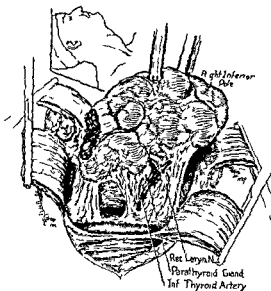


Fig. 6 With the gland mobilized and inverted the typical and most common relationship is shown of the recurrent laryngeal nerve to the lower pole of the gland and the inferior thyroid artery. Note the direction of its course toward its point of entrance into the larynx also the quite common location of the inferior parathyroid gland.

the intra thoracic extension has been located. In all of the cases the recurrent laryngeal nerve has not been stretched, and has been in its usual position except that frequently it is pushed more closely against the trachea than usual.

In the course of performing several thousand thyroidectomies, the thyroid lobes routinely have been grasped with our own special grasping forceps and not only have both lateral lobes been dislocated from their beds after detaching them laterally from the internal jugular vein but they have been so dragged upon that they were displaced across the trachea so that the dislocated lobe rested bottom side up upon this structure. Temporary, or permanent paralysis of the recurrent laryngeal nerve has not occurred following this procedure. During the last 3 years we have repeatedly located the recurrent laryngeal nerve in the cellular tissue below the main trunk of the inferior thyroid artery by palpating it somewhat on the stretch and have taught every surgical fellow in the clinic who has served as an assistant to locate the recurrent laryngeal nerve at this point by palpation. As the result of this procedure no recurrent laryngeal nerve paralysis has occurred.

The course of the recurrent laryngeal nerve is constant but the shape and extension inferiorly and laterally of the thyroid tissue of the lower

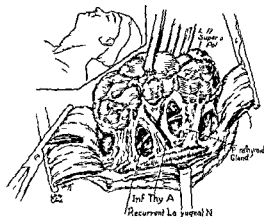


Fig. 7 In this operative dissection the nerve has been exposed up to the point at which it enters the larynx. Note its division into two branches, one larger than the other. I surmise this is an extralaryngeal separation of the nerve into the segments to supply the abductors. We have repeatedly seen this extralaryngeal division in the course of our operative dissections of this nerve. Note again the quite constant location of the parathyroid gland in its position against the larynx.

pole of the thyroid gland are quite inconstant. Not infrequently there will be extensions of thyroid tissue from the posterior aspect of the lower thyroid pole. Often these extensions will so approach the course of the recurrent laryngeal nerve that this structure unless visualized and protected, can easily be injured.

The plan of leaving a strip of thyroid tissue over the region where the recurrent laryngeal nerve is presumed to be because of fear of injury to that nerve not infrequently results in leaving too large segments of thyroid tissue thus inadequate thyroid tissue is removed and the hyperthyroidism persists or recurs.

Every surgeon in the clinic operating upon thyroid glands has learned to dissect and demonstrate the recurrent laryngeal nerves. With the lateral lobe of the thyroid grasped in double hooks and pulled up out of its bed, the common carotid artery and internal jugular vein then are dissected and held outward by a special blunt retractor thus exposing the areolar tissue between these vessels and the trachea. In this region the trunk of the inferior thyroid artery is demonstrated. As is shown in Figures 2 to 7 the angle of approach of the recurrent laryngeal nerve is quite constant as it passes either behind or in front of the inferior thyroid artery, to reach the point at which the nerve enters the larynx by passing beneath the lowest fibers of the inferior constrictor muscle where this structure is attached to the horn of the

thyroid cartilage. At this point, just below the inferior thyroid artery, the recurrent laryngeal nerve can usually be palpated, and it is at this point that we routinely demonstrate the nerve trunk.

The trunk of the recurrent laryngeal nerve at this point is considerably larger than the lead in the average magazine pencil. It is of such definite thickness that it can be palpated easily as it is pushed and rolled against the cartilaginous rings of the trachea. The course of the recurrent laryngeal nerve beneath and above the inferior thyroid artery can usually be demonstrated by introducing a pair of right angle clamps over the nerve and beneath the artery, opening the clamps gently.

Although this method of demonstrating the trunk of the recurrent laryngeal nerve below the point where it passes behind the inferior thyroid artery, does not in many of the cases result in exposure of the nerve from the level of the inferior thyroid artery up to the point at which the nerve enters the larynx, its course here may very readily be visualized by placing a finger on the tip of the thyroid cartilage and laying a hemostat from that point down to the point where the trunk of the nerve is in plain view.

It is at this point, between the horn of the thyroid cartilage and the point where the nerve passes under or over the inferior thyroid artery, that the greatest number of injuries to the recurrent laryngeal nerve is produced. It is in this short course that the nerve is sometimes imbedded in thyroid tissue, or is frequently overlapped by thyroid tissue and pressed against the laryngotracheal junction. It is at this point that the upper branch of the inferior thyroid artery, as it rests against the trachea and enters the gland, is not infrequently torn in performing subtotal thyroidectomy. Attempts to control bleeding, at this laryngotracheal junction, from the upper branch of the inferior thyroid artery after the surface of the gland has been cut across anteriorly, sometimes result in passing the hemostat so deeply between the trachea and the stump of remaining thyroid tissue that the nerve is unknowingly caught at its most anterior point, just before it disappears behind the inferior constrictor muscle.

If the trunk of the recurrent laryngeal nerve has been demonstrated and its course visualized, it is obvious that attempts to control bleeding at this point from the upper branch of the inferior thyroid artery will endanger the nerve, a local ligation should not be applied, but the main inferior thyroid artery outside the point where the recur-

rent nerve passes over or beneath it should be ligated. By following this procedure, injury to many a recurrent laryngeal nerve will be avoided.

When the recurrent laryngeal nerve passes in front of the inferior thyroid artery, as it occasionally does, the course of the nerve up to the point at which it enters the larynx is usually much clearer than when it passes beneath the artery, and not infrequently in such cases the entire trunk of the nerve up to its point of disappearance into the larynx can be seen. At times the sharp angulation of the nerve as it passes into the larynx can be demonstrated. In an occasional case the nerve, as shown in Figure 7, may split into the relatively large group of fibers innervating the adductor muscles of the cords, the cricoarytænoideus lateralis, and the relatively small group of fibers innervating the abductors of the cords, the cricoarytænoideus posterior.

In the course of performing subtotal thyroidectomy and the dissection and demonstration of the recurrent laryngeal nerves, parathyroid bodies are frequently encountered and are always looked for. No attempt is made, however, to dissect these structures since the situation here is quite different from that of demonstration of the recurrent laryngeal nerve in that the parathyroids are dependent upon small end vessels for their blood supply and attempts to dissect and demonstrate these structures could well interfere with their blood supply and result in loss of their function.

CONCLUSIONS

A technical method of dissecting and demonstrating recurrent laryngeal nerves has been employed for over 3 years in performing subtotal thyroidectomy in more than 3000 cases. We have refrained from publishing this plan or advocating its use until it had been employed for a sufficient time and in a sufficient number of cases so that we could safely speak about it after a justifiable amount of experience.

We have all illogically accepted unproved statements of the past that manipulations around the region of the recurrent laryngeal nerve would produce interference with the function of that nerve.

This method, in competent hands (and no plan should be expected to fit incompetent ones), will not increase but rather definitely decrease the number of injuries to the recurrent laryngeal nerves. It will also encourage the removal of larger amounts of thyroid tissue, without added danger to the nerves.

BILATERAL NON-TUBERCULOUS ILIOPSOAS ABSCESS

MARIE ORTMAYER M D Chicago, Illinois

CHRONIC psoas abscess of other than tubercle bacillus origin is rare. No instance of bilateral non tuberculous iliopsoas abscess was found in the literature. The one to be reported occurred following pneumonia in a young girl who was ill with fever for 5 months and recovered after drainage of the abscesses.

Tuberculous psoas abscess is a well known condition of considerable frequency especially in children, originating from tuberculous caries of the lower dorsal or upper lumbar vertebrae, as a rule, and traversing downward along the planes of psoas muscles to point above, but most commonly below, Poupert's ligament.

Acute iliopsoas abscess due to the Staphylococcus aureus or albus or streptococcus, results according to textbooks on surgery (2), from trauma or strain of the muscle fibers with resulting hematoma and infection with pus formation. L. Long cites 6 cases of such abscess, 4 in boys under 17 years of age with a history of injury preceding the onset, 1 in a woman during the puerperium, and the sixth in a boy of 17 years ill for a year after. The first 5 had quick and permanent recovery following drainage of the abscesses from behind the iliac fascia or behind the iliopsoas muscles. In a discussion, Dr. Urban Maes cited 5 acute cases he had seen without a previous history of injury but following furuncle or carbuncle, Staphylococcus albus being the infecting agent. Reporting of so many instances by two men raises the question of the possible high frequency of acute iliopsoas abscess in spite of the meager number reported in the literature.

Curiously enough chronic iliopsoas abscess of other than tubercle bacillus infection has its origin as in the author's patient not from caries of the vertebrae but from perforated empyema and is found therefore under the subject of complications of empyema as empyema necessitatis or migrans. The literature before 1900 contains most of the references, because spontaneous perforation of empyema is much less common since x ray has been added to the diagnostic armamentarium of chest diseases. Unusual positions of encapsulated empyemas such as the basal and mediastinal collections of pus, are now more readily detected while a prolonged course of empyema without surgi-

cal drainage is the exception nowadays. Spontaneous perforations of empyema, however, still occur (6, 10, 16, 27). Rupture into the esophagus the pericardium into the stomach or abdominal cavity via the diaphragm into the urinary passages into the bowel and through the visceral pleura into the lung are cited. 'Pulsating pleurisy,' a dramatic variation of the escape of pleural pus through the chest wall usually in its thinnest places near the sternum or lateral to the pectoralis is mentioned in all the textbooks. Rarely mentioned but 'very remarkable are those which pass down the spine and along the psoas into the iliac fossa, and simulate a psoas or lumbar abscess' (21). Abscesses of this latter type are discussed in this paper.

Because of the difficulties in diagnosis and the extreme rarity of instances reported in the English language especially, the following patient's course is given in some detail.

C. D., a girl aged 15 years entered the hospital November 18, 1936. She had been well and in school until she caught cold 5 days previously. After remaining up and about for 7 days she developed severe general abdominal pain followed by a chill lasting 30 minutes a temperature of 101 degrees and inability to void. Her physician sent her to the hospital with a diagnosis of acute abdomen.

On entrance the temperature was 101 degrees the pulse 130 and the respirations 40. Well developed and fairly well nourished, this girl seemed acutely ill. Her expression was apathetic, she was moving markedly, the pharynx moderately injected, the cheeks flushed and respirations shallow and rapid. Postnasally there was a thick greenish discharge. The right lung was hyperresonant in its upper and middle lobes and dull over the lower. Fine rales were heard in the middle lobe, diminished breath sounds over the lower lobe without rales. By the following morning the left lung had developed flatness in the base with tubular breathing but no rales. The heart was rapid and regular not enlarged. A murmur almost presystolic in time was present loudest over the pulmonic area. The abdomen was rigid almost boardlike and extremely tender, most marked in the upper right quadrant. Marked tympanites was noted but no masses were palpable. The rectal and vaginal examinations were negative. The extremities were normal with normal reflexes.

Blood count showed hemoglobin 80 per cent, red blood cells 5,130,000, white blood cells 62,000, differential blood count polymorphonuclears 94 per cent, lymphocytes 2 per cent. The urine was normal except for a trace of albumin and occasional pus cell. The sputum was scant mucopurulent and contained many diplococci resembling pneumococci. At this time no x ray pictures were taken. Diagnosis: bilateral lobar pneumonia.

The patient appeared extremely toxic, cough was frequent though unproductive of much sputum, respiratory embarrassment and pains in both lungs were present for

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Fig 1 Anteroposterior view November 28, 1936, showing relatively clear right chest, shadows in lower left chest with obliteration of diaphragm and stomach air bubble, but with the heart shadow hiding the probable pathological condition in the left posterior pleural cavity



Fig 2 Left anterior oblique roentgenogram which was taken on December 8, 1936, showing shadow in the left posterior costomediastinal pleural cavity. From this infected area somewhere pus can have perforated downward

3 days, for which small amounts of codeine and morphine were given. Abdominal pain, generalized or shifting, continued for 10 days, catheterization was necessary for 2 days, diarrhea was quite persistent. Both lower lobes of the lung became dull to flat, with absent fremitus, with minimal rales, with distant tubular breathing only near the spine. Tympanites and "high standing diaphragm" interfered with evaluation of signs. The right chest gradually cleared and breath sounds came through by the end of 2 weeks. Though distention of the abdomen decreased at this time, tenderness was marked over the spleen and in both inguinal regions. The temperature had fluctuated daily from 100 to 104. The white blood count dropped in the first 4 days from 62,300 to 32,600 with the polymorphonuclears 97 per cent.

The x-ray diagnosis of this period was. Probably unresolved pneumonia of the left base. Fluoroscopic check for fluid was inconclusive, as the patient could be moved with difficulty (Fig 1).

Toward the end of the third week of her illness, the patient had a chill lasting 3 minutes. A consultant, finding a diagonal line of flatness posteriorly left, extending from the sixth vertebral spine downward almost to the posterior axillary line with egophony, bronchial breathing, and crepitant rales above it, made a diagnosis of left lower lobe atelectasis following bilateral lower lobe pneumonia. A second fluoroscopic examination verified the triangular shadow in the left chest near the spine and back of the heart (Fig 2). Left posterior pleural sinus pleuritis with effusion or suppurative was also considered, but as thoracentesis on three occasions by the internes failed to yield fluid or pus, the diagnosis was in doubt. The diagonal left posterior pleural flatness and its accompanying x-ray shadow gradually receded in the next few weeks and had completely disappeared by the end of the second month of illness.

Search continued for the cause of the temperature, which after the first month had dropped from 102 degrees to normal and remained so for 36 hours, only to rise again and remit once daily, in quite irregular fashion, from 99 degrees or thereabouts to over 100, 101, at times even to 103 degrees, for 2½ months more. The red blood count had

dropped to 2,900,000, the hemoglobin to 52 per cent, and the white cells to 13,800 with 58 per cent polymorphonuclears. The early diarrheal stools were repeatedly negative for occult blood, ameba, ova, pus and bacilli of the typhoid group. No tubercle bacilli were found in the sputum, only pus cells and lance-shaped diplococci. On the blood cultures yielded no growth, the Widal, typhoid, paratyphoid, and undulant tests were negative, the tuberculosis fixation was slightly positive. The area of infiltration of the Mantoux skin test was 1 centimeter at the end of 48 hours. In the urine mild traces of albumin were found, 15 to 20 pus cells and colon bacilli. Pyelograms, colon roentgenogram, and spinal x-ray films were normal.

Late in the second month of illness the patient began to complain of occasional vague abdominal cramping, indefinitely located, but later referred to both lower quadrants where some rigidity and tenderness were noted, especially left.

After a week, the rigidity of the abdomen became less marked and pain was practically absent. Firm masses could now be felt fixed in both iliac fossae. The left was the better outlined and the larger and lay just below the anterior superior spine of the ilium. For a month these masses definitely increased in size, though they were not tender. They were shown to be separate from the pelvic organs and colon. Free motion of the hip joints was possible, without pain!

Three and a half months after onset of illness in this girl, the final medical opinion was

In view of the stormy onset with "cold" and anuria, which was the beginning of a bilateral pneumonia, or possibly even of bilateral pleurisy with effusion; in view of the leucocyte count of 63,000 with persistence of polymorphonuclear neutrophils in high percentage, the finding of the triangular area of flatness occupying the posterior left pleural sinus position, with its gradual recession and clearing, the persistence of temperature in spite of this clearing, the indefinite abdominal pain appearing at the end of 2 months' illness, with localization of rigidity and tenderness in both lower quadrants and the detection of bilateral masses, gradually enlarging and fixed over the iliopsoas



Fig 3 Anterior attachments of diaphragm (viewed from below and inside). Illustrates (as at 1, 2, 3) points through which pus from anterior pleural sulcus could perforate downward. (From Spalteholz)

muscles. I am forced in spite of the failure to obtain pus on puncture from the pleura to make a diagnosis of low grade pus infection originating probably from a left posterior encapsulated and perforated pleural sinus empyema and traveling via the posterior mediastinum and retroperitoneum downward in front of both psoas sheaths to localize as bilateral abscesses in the iliac fossa.

These two abscesses were drained extraperitoneally above Poupart's ligaments near the anterior superior spines of the ilium in front of the psoas sheaths beneath the abdominal musculature and fascia. Direct smears from the pus on both sides yielded a gram positive diplococcus with capsule and a gram negative bacillus. Cultures failed on the diplococcus but the gram negative bacillus grew anaerobically. The guinea pig inoculated with pus from the abscess failed to develop tubercle bacillus infection in 8 weeks. Necrotic material obtained from the right abscess was composed of fibrin red cells polymorphonuclear neutrophils mononuclears and plasma cells and upon microscopic examination was found to be granulation tissue.

With evacuation of pus the temperature dropped promptly the blood count became normal and both incisions healed. Very small hard masses connected with the lower end of both scars could still be felt but the patient felt well had remained temperature free and had gained weight on June 15, 1937 when last seen 7 months after the onset of her illness.

Although there are some omissions in the recording of sequence of symptoms and chest findings in this patient and a failure to obtain pus from the left chest possibly due to aspiration too far lateralward or to inspissation of pus, which cast doubt on the origin of these bilateral psoas abscesses from perforated empyema there seems to be enough similarity to other reported cases which were subjected to autopsy or clinically better established than the author's to justify the

diagnosis. A hematogenous or lymphatic origin bilaterally into the prepsaos fascia seems even more fanciful and would be more rare. The recovery of the pneumococcus like organism (necrophorus) is apparently a secondary matter in many pus processes from both abscesses and the spurtum the occurrence of encapsulated empyema of the posterior pleural sinus in pneumonias giving a roentgen picture similar to the author's (3, 14, 26) the tendency of left encapsulated empyemas to perforate and travel downward into the lumbar and iliac fossa regions give credence to the conclusions.

Twenty five previously published cases all unilateral, 14 of them fully discussed by Bouveret (4, 5), have been found of 'migrating abscess' originating from empyema (11, 13, 17, 19, 20, 23, 24, 28). One of these pointed somewhere in the anterior abdominal muscle region 7 in the iliac fossa or below Poupart's ligament, 1 as low as the knee and 17 in the lumbar region between the lower rib margins and the iliac crests. All these abscesses developed on the same side as the empyema and in 19 in which the position of the empyema is definitely mentioned 5 only are right 13 are left and 1 is left and right. The latter however on autopsy showed the fistulous tract to be connected with the left empyema and an egg sized encapsulated collection of pus on the right diaphragmatic pleura to be totally unconnected with the pus in the upper two thirds of the left psoas. This instance of a 10 year old male published by Foot (11) is further interesting because of the very short illness of 3 weeks duration and the dispersal of pus beyond the left psoas into the spinal canal as well as into the right back muscles. Of the 17 patients in which sex is mentioned, 10 are male. Eighteen whose ages are given range from 9 to 35 years, 7 of them in the second decade of life. The existence of empyema was known or suspected anywhere from 2 to 3 weeks to 1½ years before the diagnosis of distant abscess was made. Either the abscesses pointed spontaneously or they were drained surgically after a tumor presented in one or more of the three areas. When the perforation of the pleura by pus occurred early in the disease and acutely severe pain in the thorax was not to be present, but not invariably so. In only 2 patients, Bouveret's own and that of the author, did the empyema disappear completely a considerable time before the discovery of the iliopectus abscess. Bouveret's patient a female of 31 had a proved left empyema which had been tapped 21 days after onset of left pneumonia with evacuation of 2100 cubic centimeters of pus. Repeated tapping and finally drainage, though it definitely improved

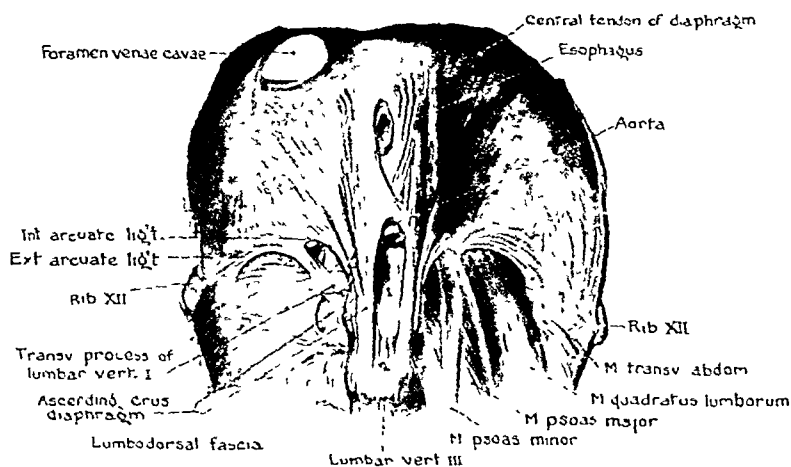


Fig 4 Posterior attachments of diaphragm (viewed from below and inside). Illustrates hiatuses of aorta and esophagus, origins of left psoas muscles and sheaths from internal arcuate ligament, and quadratus and its sheaths from external arcuate ligament. (From Spalteholz)

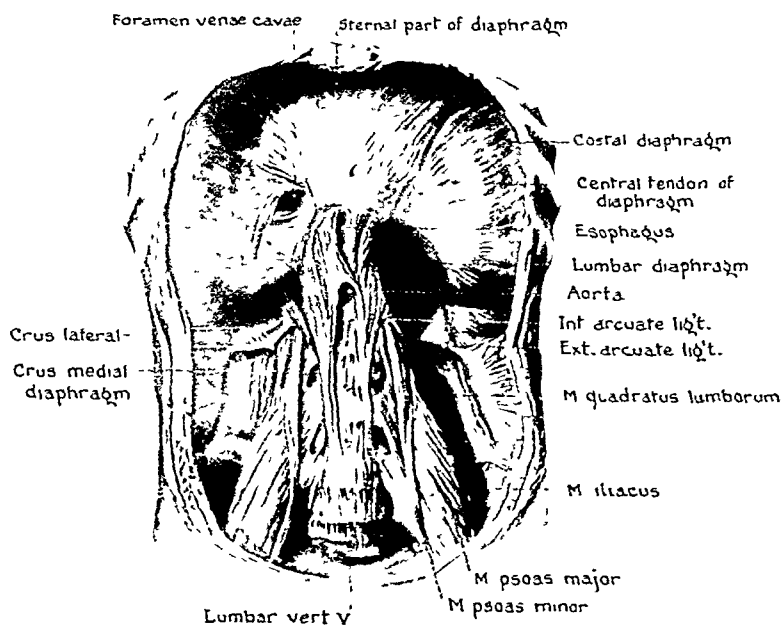


Fig. 5 Similar to Figure 4, but including lower projections of psoas and quadratus muscles on both sides. Illustrates how central descent of pus through the aortic hiatus could more easily spread bilaterally at third lumbar anterior to right and left psoas muscles, than if pus from the left pleura had pierced as far lateralward as the internal arcuate ligament

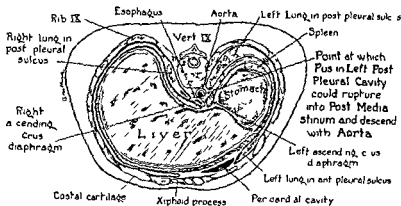


Fig 6 Cross section at level of ninth thoracic vertebra. Illustrates relationship of posterior pleural space (outlined in deep black) to posterior mediastinum, aorta and diaphragm. (Modified from *Topography of the Thorax and Abdomen* by Peter Lotter)

the chest did not reduce the temperature. Eventually, 13 months after her pneumonia onset the patient evacuated pus spontaneously from the left groin below Poupart's ligament, with cure! Several patients had final clearing of the chest when the abscesses drained. Three of the abscesses developing in the left lumbar region were pulsating—one of Courbon in a female of 24 who recovered, a second of Owen Rees, in a male of 9 years who came to autopsy (perhaps tuberculous pleurisy but with sinus tract from left pleura not from caries of vertebra) and a third of Dunin also subjected to autopsy. Bouveret gives a very able discussion of the mechanics of pulsating pleurisy (57) and the differentiation between these pulsating migrating abscesses and aneurism of the abdominal aorta.

When it is realized that of 19 patients in whom the outcome is definitely reported, 13 resulted in cure and 6 in autopsy, it is not surprising that it is still a matter of conjecture as to the exact manner in which the perforation of these pleuritis results in migrating abscess.

The appearance of pus anteriorly among the muscles of the abdomen and pointing somewhere below the diaphragm seems to be due to rupture through the anterior pleural sulcus (50). Whether the pus travels *via* the anterior mediastinum just back of the sternum through the known weak spot of the diaphragm between its sternal and costal origins or through the interdigitations of costal diaphragm and anterior abdominal muscles cannot be determined from reports (Fig 3). The autopsy on Loomis patient revealed the perforation in the extreme anterior border of the diaphragm, the fistula passing into the inferior peritoneum, leaving over the liver and downward in

front of the ascending colon to point above Poupart's ligament.

As to the psoas abscesses, J. J. Clark has contributed the most convincing proof in 1910.

He reports a male negro 35 years of age with a brawny swelling over the right thigh seen first complaining of pain over the right hip, developing 1 year after an attack of pneumonia. The swelling was treated as a localized abscess and drained. Later x-ray studies revealed a shadow in the right chest which was proved by thoracotomy to be empyema. Clark's serial x-ray studies after lipiodol injection into the right pleural cavity show two pools of dye above and behind the right diaphragm at the 4th and 5th interspace; later dye has passed "through the diaphragm close to the spine and under the right internal arcuate ligament" then a large cavity in the body of the psoas, which he believes proved by the striated appearance of the lipiodol among the muscle fibers; later a clot of oil over the right sacrum.

Whether one is entirely convinced or not of the interpretation of the reason for the striated appearance of the lipiodol in Clark's films, one must recognize this sole instance of x-ray visualization of the path taken by this pus as a valuable contribution.

It is assumed by most of the writers reporting instances of unilateral psoas or lumbar abscess that the pus has escaped from the empyema after perforating the pleura through the internal or external arcuate ligaments (Fig 4). Anatomically, however, it is difficult to visualize a bilateral spread such as resulted in the authors' patient from perforation through either. Any perforation through the internal arcuate would seem to confine pus to a spread downward in front of or within the psoas on the same side and through the external ligament to an equilateral path posterior to the psoas or within the quadratus lumborum (Fig 5). The most careful autopsies

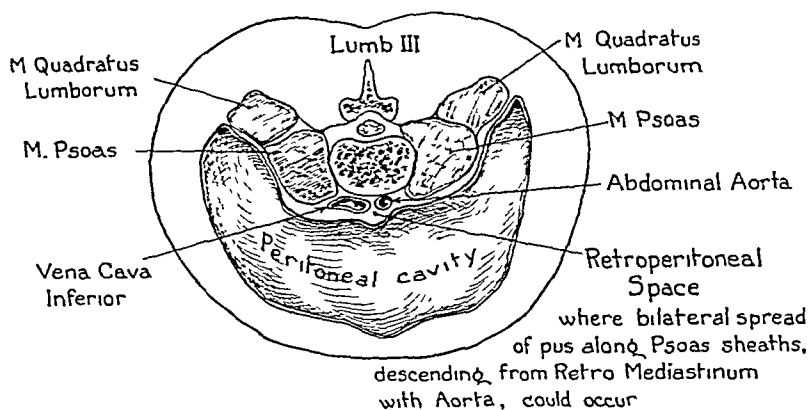


Fig 7 Cross section at level of third lumbar vertebra Illustrates relationship of retroperitoneal space to great vessels and right and left psoas muscles and point at which pus could spread bilaterally anterior to these muscles (Modified from *Topography of the Thorax and Abdomen* by Peter Potter)

examination, that in a patient of Foot (11), corroborates this hypothesis, for the sinus was found to pass from the left pleural space behind the left crus of the diaphragm, posterior to the internal arched ligament, into an abscess in the upper two-thirds of the left psoas. The psoas sheath was intact, the pus was deep in the substance of the vertebral border of the muscle (Fig. 5). Tees believes that he traced a lumbar abscess "invading the quadratus lumborum" through the external arcuate ligament when he surgically explored his patient. Certainly the location of pus in the pleura and the primary site where lysis has produced perforation, as well as the routes of dispersion available at this point, must all influence the eventual paths of the pus, even though conceivably pus may spread anywhere. The variety of ways in which tuberculous pus traverses downward (1, 15) illustrates the rôle that is played by the exact position of exodus of pus from spinal caries. The pus may hollow out the sheath of the entire psoas, bulging it to the size of a man's arm, or less commonly may stay completely anterior or posterior to its fascial sheaths. Prevertebral cold abscess is usually to left or right of center, uncommonly directly median and this may explain the infrequency of bilateral tuberculous psoas abscess. The bilateral abscesses of the author's patient were located anterior to the sheath of the iliopsoas muscles. If these both originated from the left posterior pleural sinus empyema, it is easier to assume central evacuation of pus from the mediastinum into the retroperitoneum with bilateral spread than rupture through the left internal or external arcuate ligaments (Figs. 6 and 7). That perforation from the left posterior pleural cavity

into the posterior mediastinum occurs is proved by autopsy in the cases in which mediastinal abscess is found together with perforated empyema. Foot's (12) patient in whom the mediastinal pus lay anterior to the aorta and perforated the esophagus, as well as several of Knauer's perforating the esophagus prove this. It is not too great a flight of the imagination, especially when considered in the light of cross-sectional anatomy (25), to assume that pus so escaping could migrate downward along the great vessels between the crura of the diaphragm or through the esophageal hiatus.

As most of these reports were published in the early medical literature, it is not strange that bacteriology of the abscesses is so seldom mentioned. Usually the authors have merely stated that they were non-tuberculous. The direct smears herein reported demonstrating a diplococcus similar to that found in the sputum, resembling pneumococcus morphologically, and the additional gram negative bacillus found in the pus from the abscesses, with failure to develop tuberculosis in the guinea pig and apparent cure in the patient, establish the author's case, incomplete as it is, as bacteriologically the most fully studied in the literature. Knowledge of this report should stimulate more accurate study of the non-tuberculous psoas and lumbar abscesses occurring in the future.

SUMMARY

A case of bilateral iliopsoas abscesses originating from probable left posterior pleural sinus suppuration following pneumonia has been reported.

No other instance of bilateral abscesses of this type has been found in the literature.

The 25 other unilateral chronic abscesses, re-

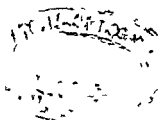
ported in the literature as originating from perforated empyema and pointing at considerable distance below the diaphragm, are briefly reviewed and discussed.

The differences between these abscesses and the acute traumatic abscesses, usually of staphylococcus etiology, and tuberculous lumbar and psoas abscesses are mentioned, with special reference to anatomical variations in the paths of the migrating pus.

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TENOSYNOVITIS OF THE LONG HEAD OF THE BICEPS HUMERI

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TENOSYNOVITIS of the long head of the biceps is a non-specific inflammation of the tendon and its sheath. It is a shoulder complex characterized by pain, of various degrees, along the bicipital groove of the humerus, inability to raise the arm above the level of the shoulder, and diminution or loss of all other functions which put stress upon the tendon. It has a tendency to chronicity and, if untreated, may ultimately lead to muscular atrophy of the shoulder group of muscles and to a certain degree of loss of function.

The general literature, as far as I was able to ascertain, is silent on the subject, with the exception of some limited accounts in the French literature. Leclercq and Rouresco speak of tenosynovitis of the long head of the biceps humeri in connection with injuries of the shoulder in industries and the degree of disability thereof. They, evidently, took it for granted that the condition was well known and did not enter into further details. F. Pasteur,¹ medical colonel of the military hospital, Val-de-Grâce, recognized the condition in all its aspects, described it fully and clearly and raised it, unmistakably, to the rank of a distinct clinical entity.

Although I have been familiar with this condition for many years, interested my colleagues in the subject and presented clinical cases in clinics, my failure to record the facts in print gives Pasteur the priority of record.

Tenosynovitis of the long head of the biceps humeri is the most common cause of periarthralgias of the shoulder, a view which is fully shared by Pasteur.

In spite of the fact that the clinical picture is definite, constant, and easy of recognition, roentgenologists, orthopedists, and physiotherapists are mute on the subject.

ANATOMY

The biceps muscle has two heads. The short head arises from the coracoid process, close to the coracobrachialis. The long head arises from the

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¹Some articles refer to E. Pasteur, others to F. Pasteur. I believe, however, that both are the same writer.

top of the glenoid cavity. It takes insertion into the supraglenoid tuberosity and the glenoid ligament by a long tendon (9 cm), which is either bifurcated or trifurcated at its origin. In the latter case, there is one intermediate portion attached to the scapula, and two smaller, collateral portions which diverge from each other and blend into the labrum glenoidale. The tendon glides over the head of the humerus, within the joint, invested by a synovial sheath (which is an evagination of the capsule), and then slides into the intertubercular, or bicipital groove, which is covered by an expansion from the pectoralis major and ends blindly opposite the insertion of the latter muscle.

PHYSIOLOGY, FUNCTION OF TENDON

The tendon of the long head of the biceps takes part in all the movements involved in either fixation or mobility of the upper extremity, which explains its vulnerability. It is an important factor in the dynamics of the upper limb. Together with the long head of the triceps, it helps to stabilize the humerus against the glenoid fossa (Steindler). According to Callander, the tendon of the long head of the biceps acts as a "standardizing brace" and "prevents any sudden impact between the head of the humerus and the underlying arch." Duchene of Boulogne, in his work on the physiology of movements, assigns important function to the short head of the biceps and looks upon the long head as a mere supinator, flexor muscle.

The function of the tendon of the long head of the biceps can be summarized as follows:

1. It helps to maintain and coaptate the head of the humerus against the glenoid cavity.
2. It reinforces the capsular ligaments.
3. It prevents the head of the bone from being pulled too close upward under the acromium (Treves).
4. It supplements the deficiency of the subspinous muscle.
5. Both biceps heads are flexors and medial rotators of the arm at the shoulder; both are abductors, the long head abducts the arm and rotates it inward.

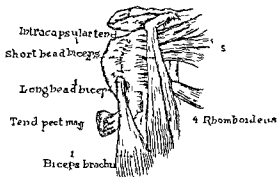


Fig 1 Shows long head of the biceps entering capsule of shoulder joint (From Testut's *Traité d'anatomie humaine*)

ETIOLOGY

The etiological factors, although varied, are the following

- 1 Trauma
- 2 Metastatic infection from a systemic source
- 3 Exposure to sudden changes of temperature especially to cold and dampness
- 4 Generalized effusions in serous cavities and spaces
- 5 Rheumatic tendencies

Trauma Sudden muscular efforts in the course of infectious diseases are apt to initiate this syndrome, especially in the course of typhoid or influenza. Two of Pasteur's cases were the result of colon bacillus infection while another occurred during an infection of bacillary dysentery.

Hard upward pull upon a cork screw of a tightly corked bottle may bring about the condition.

Fall upon the extended hand may produce the lesion. In this connection it may be well to mention the occasional, coexisting pain in the corresponding shoulder in Colles fracture, which is usually noticed some days after the fracture. This is, very likely due to a coincidental injury of the tendon of the long head of the biceps which is overshadowed by the Colles fracture. Fall upon the extended hand was the etiological factor in 23 of the 32 cases of Pasteur. In 8 of 10 cases the patients were males past forty years of age.

Fall upon the shoulder is a frequent cause.

An attempt to prevent a fall may cause a sudden pain along the bicipital groove, which may be responsible for the syndrome.

Sudden jar of the shoulder among straphangers is apt to cause this condition.

Faulty position of the arm is another cause. False movements while the arm is in abduction and external rotation are also factors. Rheumatic

patients may develop this syndrome on the slightest exertion or false movement.

Muscle strain in systemic diseases may cause inflammatory changes in the tendon or its sheath.

The 4 remaining etiological factors are of lesser importance and frequency than trauma. Although they can initiate an attack, they are usually associated factors in the more severe attacks which are caused by trauma.

PATHOLOGY

The inflammatory process involves the tendon as well as its bursa which surrounds it. Although a tendon was never sectioned by analogy it may be inferred that all the inflammatory stages may be present, such as serous effusion, plastic exudate, fibrinous exudate, and adhesions. The tendon swells and loses its elasticity. Failure of the tendon to assist in the coaptation of the head against the glenoid cavity may lead to an outward dislocation. The tendon encased in a tight tunnel and pressed against arthritic deposits may gradually wear out, atrophy, and even disappear, in which case the remaining portion attaches itself into the bicipital groove. The muscles in and about the shoulder may atrophy.

SYMPTOMATOLOGY

There is pain along the bicipital groove, both subjectively and objectively. The subjective pains may be somewhat diffuse about the shoulder, but the objective pain is *always constant and always located in the bicipital groove*. It can be definitely elicited by pressure of the tip of the examiner's index finger upon the bicipital groove, especially when the arm is abducted and thus contrasts with the lack of response to pressure upon other points on the shoulder. If one is familiar with this situation it enables the examining physician to foretell the exact location of the pain before examination. A patient is frequently intrigued by the fact that the examining physician is able to locate and outline the location of pain without having previously examined the patient. The pain is superlative in quality in the acute cases. It is both diurnal and nocturnal exaggerated by movements of the arm or pressure upon the head of the humerus. The patient is unable to sleep and drugs have little or no influence upon the pain except perhaps morphine in half grain dose. In most cases the pain occurs suddenly occasionally it may be insidious.

Clinically there are three distinctive types:
1 The acute type characterized by violent pains in the shoulder both diurnal and nocturnal little or not at all influenced by drugs.

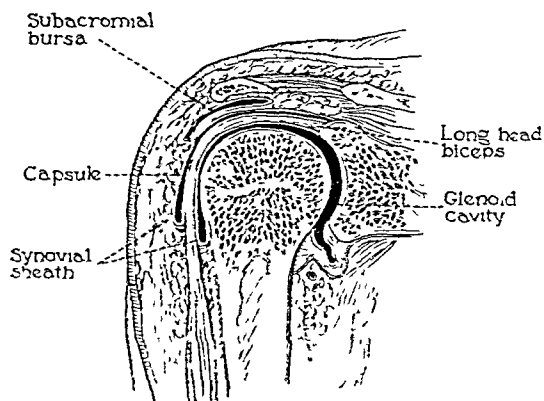


Fig. 2 Shows tendon of long head of biceps in relation to the joint, capsule, and humerus (After Callander, *Surgical Anatomy*)

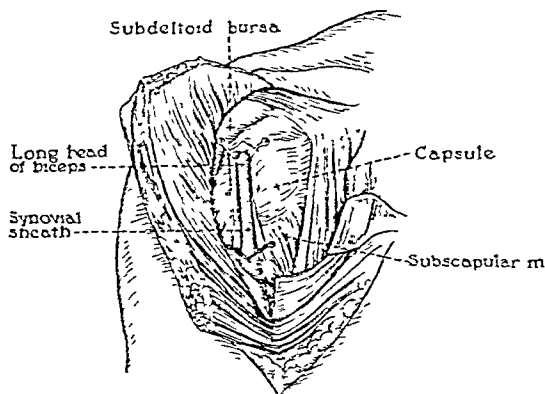


Fig. 3 Shows tendon of long head of biceps with synovial sheath split and reflected outward (After Callander, *Surgical Anatomy*).

There is loss of shoulder function, because of pain. There is inability to raise, abduct, or place the arm against the back. Passively, the arm can be raised to the level of the shoulder, but not beyond that point. There is a *specific tenderness along the bicipital groove*. The pain lasts from a few days to a couple of weeks, when it gradually subsides, especially if diathermy has been used, or it may become subacute.

2. The subacute type, in which the pain is less severe, not so continuous, and may be paroxysmal, especially at night. There is some impairment of function and the patient learns to raise the affected arm with the opposite hand. The arm can be raised to the level of the shoulder and even beyond, although the movements are tolerably painful. The subacute type may be a continuation of the first type, or it may start as such in frank rheumatic cases. This second type may last from a few weeks to a few months, or it may merge into the chronic type.

3. The chronic type exhibits to a lesser degree all of the previous symptoms. The patients learn to fix the scapulohumeral structures and assist themselves in difficult movement with the opposite arm. There is more or less voluntary and involuntary fixation of the shoulder and there may be muscular atrophy present. This type may last indefinitely or be subject to either remissions or paroxysms.

Quite recently I have seen a patient who suffered from an acute attack of shoulder pain about 3 years ago. The condition had passed through all the three stages over a period of 9 months, and had left the patient with occasional pains in the shoulder, especially at night, and with inability to raise the arm much beyond the level of the

shoulder. He was unable to place the dorsum of his hand against his back. Although his occupation required the use of a hammer, he learned to fix his shoulder and do all the work with his forearm and hand, using a short range of excursion, with the elbow as a pivot, instead of his shoulder. He was rather surprised when he realized that he had discarded the shoulder movements in his daily work and admitted that occasionally he raised his arm with the assistance of the opposite hand. The shoulder muscles were considerably atrophied. During a recent exacerbation, he had acute pain along the bicipital groove.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

Since most of the articular and periarticular affections express themselves in terms of pain and limitation of motion, it becomes a diagnostic problem to establish with accuracy the exact tissue, or structure, which is responsible for the clinical picture.

Most of the conditions which tenosynovitis of the long head of the biceps humeri resemble are due to some injury. In this affection the character of the trauma is in the nature of a jar, or sudden pull upon the tendon rather than a single, violent blow upon either shoulder, or tendon.

True enough, patients suffering from tenosynovitis of the long head of the biceps humeri may be arthritics or rheumatics, yet this factor alone is not sufficient to bring about the clinical complex, trauma being a requisite or an important contributory factor.

Topographical pain along the bicipital groove is a pathognomonic sign in this ailment.

Inability of the patient to raise his arm above the level of the shoulder, to abduct it, or place

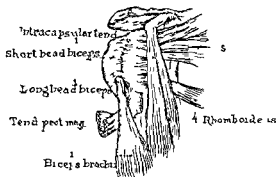


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general literature. He states, however, that the condition can be corrected by manipulation or operation

In the acute phase of tenosynovitis of the long head of the biceps, patient must rest in bed, placing the arm and forearm on 2 pillows in order to get some comfort.

Diathermy is the principal remedy, especially in the acute cases. This form of physical therapy induces hyperemia, which activates the blood supply, both superficial and deep. This, in turn, assists in the process of repair and promotes absorption of inflammatory exudates. It also maintains muscle tone and prevents atrophy. It should be administered daily from 30 to 60 minutes, preferably in the patient's home or in the hospital. I have found that patients who leave the office and come in contact with cold air do not fare well.

In the subacute stage, diathermy should also be used. However, if pain has definitely abated, gentle massage is recommended. Faradization of the tendon of the long head of the biceps is beneficial and should be administered either daily, or every other day, care being used to avoid muscle fatigue.

In the chronic cases, especially if there is muscular atrophy, massage, faradization, active and passive motion, in addition to diathermy, are definitely indicated. All forms of electrical treatment, such as high frequency, ultraviolet, infrared, carbon light and heat are beneficial and should be used in turn, the amount depending upon the relief the patient gets from their use.

Faradization diminishes pain and often allows patients to perform movements formerly impossible or painful. Galvanism is of value. Pasteur speaks of "rapid and remarkable success" in 5 cases by the use of high tension galvanism of weak intensity.

I advise my patients in the subacute and particularly in the chronic stage, to build a series of vertical shelves at a distance of 4 to 5 inches apart and instruct them to place the arm on these shelves. They start with the shelf which causes no pain, which is usually at the level of the deltoid. Then, they are asked gradually to reach higher shelves, daily, or several times a day, being guided by the absence of pain. The arm is kept on these shelves from 3 to 5 minutes. These exercises must not cause pain or tire the patient.

Potassium iodide is suggested in chronic cases.

SUMMARY

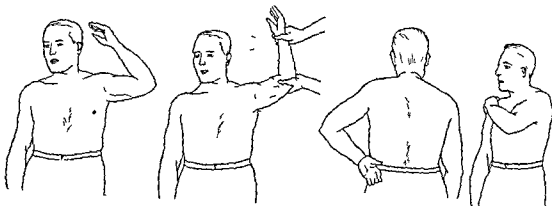
1. Tenosynovitis of the long head of the biceps is a new, yet definite, clinical entity.

TABLE I—PRESENTATION OF THE CONDITIONS
TENOSYNOVITIS OF LONG HEAD OF BICEPS
HUMERI RESEMBLES

Clinical entity	Etiology	Signs and symptoms	Function
Tenosynovitis long head biceps humeri	Trauma sudden jar, or pull Rheumatic tendency Metastatic infections Climatic changes	Diurnal and nocturnal pains, uninfluenced by drugs Topographical pain (bicipital groove) Afebrile	Inability to raise arm above level of shoulder, abduct, or place hand against back
Acute rheumatism	Definite etiology unknown (numerous contributory factors)	Polyarticular pains, often controlled by drugs Migratory pains Constitutional symptoms Febrile Diffuse local swellings, chiefly involving joints	Painful movements in any direction
Rupture of supraspinatus muscle	Blow upon the shoulder or strain with arm in abduction	Maximum pain over the tuberosity Pain, diffuse, shoulder weak Defect below and lateral to the acromion X-ray may reveal spicule of bone attached to tendon	Difficulty of raising and abducting arm
Rupture of biceps tendon	Trauma: old and arthritic Always in men Rare condition D. E. McKenna 85 cases, J. O. Rankin 4 cases from general literature	Laxness and spheroidal bulge of muscle near elbow Head of humerus drawn upward and forward, false dislocation	Flexion and supination painful Abduction of arm limited (rupture of long head tendon)
Sub-acromial bursitis	Fall or blow upon apex of shoulder Occupational (painters, for ex.) Pressure upon shoulder by heavy objects	Pain, especially nocturnal extending up to neck and down on arm Fullness beneath deltoid Tender spot below and close to tip of acromion, disappearing on abduction (latter hides bursa)	External rotation and abduction limited and painful, referred to insertion of deltoid X-ray wider space between acromion process and head of humerus (contrasts with well side)
Subdeltoid bursitis	Fall	Swelling and fluctuation over tip of shoulder Pain insertion of deltoid, bicipital groove Deltoid movements painful Muscular spasm (acute stage) Humerus approximated against scapula	Painful abduction and external rotation

2. F. Pasteur, medical colonel of the military hospital Val-de-Grâce, France, described the condition fully and clearly and should be given priority of record in medical literature.

3. The condition is the most common form of the periarthralgias of the shoulder (Pasteur).



Figs 4, 5, 6, 7 Fig 4 and 6 show movements which are limited and painful when attempted. Figure 5 shows in dotted line the extent of voluntary movement and

in full line the additional elevation with assistance (Suggested to the artist by Pasteur's photographs in *J de radiol et d'électrol*)

the dorsum of the hand against his back are like wise pathognomonic

Table I is a presentation of the conditions which tenosynovitis of the long head of the biceps humeri may resemble

PROGNOSIS

Mild and even severe inflammations occasionally subside within 5 to 6 days when properly treated and patient abstains from movements of the arm. The patient who is not in position to discontinue work as well as the patient who remains without treatment may suffer for several weeks and usually is a candidate for chronicity or recurrences

The three types already mentioned may merge into each other, the time period of each varying in various individuals. On the whole it may be said that when the cause is a mild trauma, or even a systemic, metastatic infection, the condition can be better controlled and temporized than when it is due to a severe trauma especially in older, arthritic patients. Recurrences are occasionally seen such recurrences in reality however, are exacerbations of conditions which have abated but which have not entirely subsided. I have seen violently acute inflammations subside within a few days, while mild lesions passed on into the other phases

TREATMENT

It is fair to state that the usual drugs which control or modify arthralgias, neuralgias, gout or rheumatism, have little or no effect upon tenosynovitis of the long head of the biceps and that there is no specific remedy for it. Morphine, in large doses controls the pain but is not capable

of abolishing it entirely, as the slightest movement or jar of the shoulder will bring on pain even with patient under the influence of morphine. Pasteur suggests ionization with salicylates, iodides and atropine

Much benefit and occasionally instant cure can be obtained by sudden traction upon the arm and shoulder while the arm is relaxed and in a position of abduction. The rationale of this treatment is based upon the supposition that the tendon does not fit properly in the groove and that the maneuver makes a satisfactory replacement in the groove. One may argue that since the biceps tendon fits snugly in the bicipital groove it is difficult to conceive its displacement out of the groove. Sumner L. Koch commenting on the sudden relief of pain by sudden traction upon the arm in abduction states "I am wondering if this may not be due to the tearing of adhesions rather than replacement of the tendon in its groove. As you well know, such manipulations constitute one of the helpful stunts of bone setters and they frequently secure relief in this way for patients who had persistent pain and discomfort from constant pulling and irritation of adhesions which have formed in spaces lined with synovial membrane. On the other hand E. L. Gilcreest in an article entitled 'Dislocation and Elongation of Long Head of the Biceps Brachii' speaks of many cases reported from dissecting and postmortem rooms and numerous others have been recorded as having been seen clinically but not operated upon." A. W. Meyer dissecting one thousand arms found 50 cases of marked dislocation of the tendon and many others of lesser degree. Gilcreest found no mention of any operative treatment for this condition in the

The result of accidental occlusion or injury of the ureters is governed by the location and extent of the damage.

The following summary by Robinson covers all eventualities:

- A Unilateral* 1. Section, followed by leakage and acute infection, either local or widespread
 2. Partial section with subsequent leakage and fistula formation, either uretero-abdominal or, and more likely, ureterovaginal
 3. Ligation, followed by atrophy of the kidney, with or without symptoms of renal inadequacy In some cases, acute or chronic uremia
 4. Ligation with reflex suppression and complete anuria (16 per cent—Barney)
B Bilateral 1. Double section, followed by leakage, general infection and death
 2. Double ligation with anuria and uremia, fatal if unrelied
C Partial occlusion or kinking from peri-ureteral adhesions following various abdominopelvic operations

In the 260 cases collected from the literature during the period 1925–1936, unilateral injury occurred in 236 cases, as follows:

1 Radical abdominal hysterectomy for cancer	54
2 Total abdominal hysterectomy (a) For uterine and cervical myomas or extensive pelvic inflammatory disease	48
(b) Ruptured uterus	1
3 Supracervical hysterectomy. (a) Indication not stated	26
(b) Complicated by chronic adnexal disease	18
4 Vaginal hysterectomy (a) Cancer of cervix and portio (radical Schauta method)	13
(b) Prolapse	6
(c) Myoma	3
(d) Indication not given	13
5 Salpingo-oophorectomy (a) Ruptured ectopic	5
(b) Ovarian cyst or adnexal disease	19
6 Operation for removal of intraligamentous tumors	19
7 Obstetrical procedures (a) Extrapentoneal cesarean	1
(b) Forceps	5
8 One each of the following inguinal herniotomy, incision and drainage of pelvic abscess, and operation for carcinoma of the rectum	3
9 Anterior colporrhaphy	2

CASE REPORTS

CASE 1 Unilateral injury—asymptomatic unilateral ligation Mrs N H, aged 31 years Previous operative procedure 4 years ago, left salpingo-oophorectomy for chronic tubo-ovarian disease Patient was admitted to the Israel Zion Hospital, March 23, 1932, with complaint of pain in left lower quadrant of abdomen

Pelvic examination revealed the uterus to be of normal size but displaced to the right by a tense cystic mass, which occupied the left lower quadrant The impression was that of an intraligamentous cyst.

Operative findings The left ureter had been ligated at the previous operative procedure, 1 inch from the bladder end, and the result was a huge hydro-ureter The pelvic portion of the ureter was dilated to the size of an orange; the middle third of the ureter was dilated 1 inch in diameter, narrowing to one-quarter of an inch at the upper end. The kidney was atrophic, the size of a plum.

Procedure The broad ligament was divided The pelvic portion of the ureter, which was markedly adherent to the

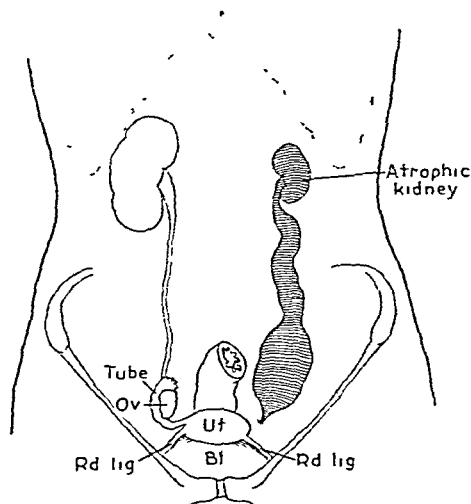


Fig 1 Giant hydro-ureter resulting from accidental ligation of distal end of ureter Case 1

adjacent tissue, was exposed and separated by blunt dissection The middle portion of the ureter was also exposed, by incising the posterior peritoneum, and freed from its adhesions The entire ureter and kidney were removed

Convalescence was complicated by a vesicovaginal fistula which healed spontaneously. The patient left the hospital in good condition, within 3 weeks of the time of operation.

This case illustrates the fact that in many gynecological operations the ureter is tied, yet convalescence is uneventful and any symptoms produced by the ligation are easily obscured by other postoperative symptoms; thus the unilateral ligation goes unrecognized, with the ultimate result that the corresponding kidney dies We are forced to the conclusion that many deaths, even when "suppression of urine" has been given as the cause of death following pelvic operations, are actually due to ureteral occlusion.

CASE 2 Ureterovaginal fistula treated by end-to-end anastomosis Y C, aged 43 years, was admitted to the Israel Zion Hospital, June 24, 1925 Primary operation, bilateral salpingo-oophorectomy, had been done 4 months previously Eight days later, the patient began to dribble urine per vaginam

The cystoscopic findings were as follows Bladder capacity was normal, the bladder urine clear Both ureteral orifices were normal except that the left one did not seem to function The catheter could be passed up easily on the right side On the left side the catheter met with an impassable obstruction $4\frac{1}{2}$ inches from the bladder

Operative procedure A catheter was passed up the left ureter as far as the site of obstruction An incision, 6 inches in length, parallel to, and about 0.5 inch above, Poupart's ligament, was made The muscle was divided by blunt dissection, and the posterior wall of the pelvis was exposed retroperitoneally After exploration, the lower end of the upper section of the severed ureter was isolated It was found to be greatly distended, its caliber being about the

4 Inability to recognize, appraise, and treat this condition adequately is responsible for invalidism, chronicity, and functional disability, which can be either improved, modified or cured, if properly diagnosed and managed

5 The treatment is largely mechanotherapy and physiotherapy

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OPERATIVE INJURIES OF THE URETER

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INJURY of the urethra bladder and ureter continues to plague the gynecologic surgeon because of its frequency as a complication of pelvic operations. Of these injury to the ureter is the most common and most serious. Various observers place the incidence of ureteral ligation as a complication in 1 to 3 per cent of all operations on the female genital organs. Although a fairly large number of case reports of operative injury of the ureter is revealed in a survey of the literature it is very likely that most of the cases have never been reported and that many of these have passed unrecognized. Caulk and Fischer speak of the accident occurring much more frequently than is generally believed. Sampson in one of the first comprehensive papers on ureteral trauma, claims that the injury either in the form of ligation or clamping 'is of common occurrence during gynecological work.

A notable presentation by Bland, in 1925, brought the literature up to that date. This paper included Herman's series of 24 bilateral cases, Barney's report on 63 cases including 32 cases presented by Sampson in 1902 and a group of 159 cases presented by Oeconomes. Thus Bland collected from the literature a total of 216 cases, and he himself gathered 125 additional cases from men active in abdominopelvic surgery. Nevertheless, he emphasizes the fact that even with this large array of cases collected it is probable that a large number of others have not been recorded or have escaped recognition.

In addition to the 8 cases recorded herein we

have collected from the literature, both here and abroad, another group of 260 cases which were reported from 1915 to 1916. This brings the total up to 710 cases, of which 109 were bilateral and 601 unilateral.

TYPES ETIOLOGY AND RESULTS EFFECTS OF URETERAL INJURY

Injury to the ureter may result from direct trauma, such as cutting (complete or incomplete), puncture crushing by clamps, or by ligation. Occasionally the wide dissection of the Wertheim technique leads to sloughing of the ureteral wall due to disturbance of its blood supply. In the majority of instances, ureteral injury is unilateral. Bilateral involvement of the ureters occurs in about one sixth of the cases.

In clinics in which the radical abdominal hysterectomy for carcinoma of the cervix is performed this operation is most frequently responsible for the occurrence of the accident. Vaginal hysterectomy is next in frequency. Abdominal hysterectomy was the primary operation in 4 of the 8 cases reported in this presentation. In 3 of them, the hysterectomy was performed for multinodular fibroid uteri, and in 2 the hysterectomy was complete. When chronic pelvic inflammatory disease distorts the anatomy during a hysterectomy for a fibroid uterus or when cervical or intraligamentous myomas change the normal relations of the pelvic course of the ureter, the risk of injury is increased. Operations for intraligamentous tumors are especially prone to this complication. In 1 case of this series the ureters were bilaterally involved during a Forthright operation.

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made it necessary to take deep bites with mass ligatures in order to control the bleeding. A transfusion of 1000 cubic centimeters of whole blood was given. Eight hours after operation, 12 ounces of urine was obtained on catheterization. No urine was voided in the following 24 hours, at which time it was determined by catheterization that the bladder was empty.

Cystoscopy was now done under local anesthesia. "Both ureteral orifices were congested, flaccid, gaping, with no visible peristalsis. No urine was seen coming from either ureter. Catheters could not be passed beyond 4 centimeters from the bladder on either side."

An immediate laparotomy was done. The previous midline incision was opened. Cystoscopy was done at the same time, with ureteral catheters in place. On the left side, the ureteral catheter was palpated at the point of obstruction, and the sutures in that region near the cervical stump were cut. The catheter was then introduced beyond the obstruction and urine began to flow. The same procedure was followed on the right side, but the obstruction was found near the base of the ovarian ligament. Urine also began to flow freely from this side. The abdomen was closed. Both catheters were left *in situ*. Convalescence was stormy, in spite of the fact that urinary secretion was adequate. The patient died on the fifth day.

Opinion. Sepsis, pneumonia, paralytic ileus

CASE 6. A. S., aged 39 years, was admitted to the Beth Moses Hospital, January 12, 1933. A total hysterectomy for fibroid uterus and lacerated, eroded cervix was followed by complete anuria for 24 hours.

The general condition of the patient appeared good. The abdomen was soft. Her only complaint was nausea with occasional vomiting. No pain or tenderness was noted over either kidney region. She was taken to the operating room 24 hours after operation and cystoscoped. Cystoscopy showed the following: "Both ureteral orifices appear motionless, no urine is seen escaping from either orifice. Ureteral catheterization was attempted and both ureters were found obstructed 1 inch from the bladder end."

Operative procedure and findings. Immediate laparotomy was done through the previous incision. Although only 24 hours had elapsed since primary operation, the pelvic tissues were markedly thickened and edematous. The normal anatomy was completely distorted by a massive exudate which completely buried the cervical stump. The tissues on either side of the latter were separated by blunt dissection. The right ureter was isolated and found to be dilated to about the size of one's little finger. It was freed downward toward the bladder until the point of obstruction was reached. The offending ligature was found to be that which included the dense basal segment of the broad ligament on each side of the cervix, together with the vascular plexus adjacent to it. Both ligatures were cut with considerable difficulty because of the depth of the pelvis, the dense exudate, and the general oozing. The ureteral catheters, which had been previously passed through the cystoscope, were now advanced up on both sides to the pelvis of the kidney and urine was immediately excreted on both sides.

The postoperative reaction was poor, the patient was in moderate shock. She was transfused 4 hours later. She was catheterized and 14 ounces of urine was obtained. During the following 24 hours the patient excreted 60 ounces of urine. Her condition, nevertheless, gradually grew worse and she expired 36 hours after operation.

In explaining such mortalities, Barney has pointed out that the suppression of urine alone is not the determining factor. In neither of these

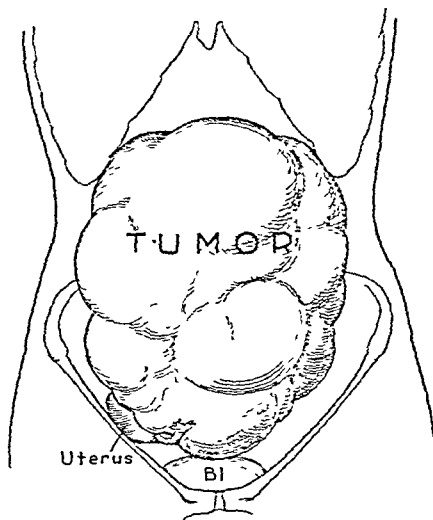


Fig 3. Huge tumor mass, originating from the left intraligamentous fossa, occupying the entire abdominal cavity, and displacing small uterus to the extreme right. Case 7.

cases was it long drawn out, as a matter of fact, the condition may exist for a much longer period of time before death ensues. Morris cites a case of anuria of 17 days' duration, while another surgeon with whom Barney corresponded, saw in consultation a patient who had passed no urine whatever for 23 days. Both these cases terminated fatally, but they serve as proof that the human system can sometimes offer good resistance to this particular onslaught. In the type of case under consideration, Barney ascribes the high mortality to other factors, such as severe and prolonged operation in a patient who is already below par and to whom the ureteral injury is merely the last straw. In our experience, deligation has proved a formidable operation which presents unusual technical difficulties. These are, chiefly, the extreme anatomical distortion, the extensive exudate, and the inevitable bleeding in the operative region.

CASE 7. Bilateral ligation treated by nephrostomy. Case No. 65218, Mrs. A. J., aged 43 years, was admitted to the Beth Moses Hospital, September 20, 1934. Her chief complaint was intermittent vaginal bleeding and marked enlargement of the abdomen. The previous history was essentially negative, except for a cesarean section 7 years ago. Pelvic examination revealed a normal size uterus which was displaced to the extreme right by a tumor mass filling the entire pelvis. Abdominally, the same tumefaction, reaching up to the costal margin on both sides, could be palpated.

Operative procedure and findings. At operation a huge tumor mass, which originated from the left intraligamentous space, displacing the uterus to the extreme right and

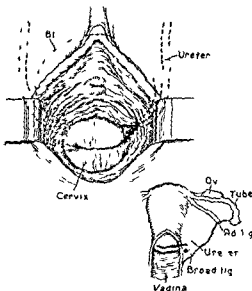


Fig. 2. Deep laceration through the left angle of the cervix extending up into the broad ligament and involving the distal end of the ureter. Case 3.

size of one's thumb. The lower segment of the ureter was found collapsed and hugging the ureteral catheter introduced from below. The two ends of the ureter were freed and an end-to-end anastomosis was performed. The ureteral catheter was passed up through the point of union and on into the upper segment as far as the kidney pelvis.

The convalescence was smooth and urinary drainage via the catheter was adequate. The patient was discharged August 15, 1925. At that time the incision was healed except for a small opening through which escaped a free watery urinous discharge (persistent urteroabdominal fistula). There was no evidence of vaginal leakage.

Bump and Crowe state that when ureteral anastomosis over a catheter is done the kidney pelvis should always be drained through a pyelostomy or ureterostomy above the line of repair. Had such prophylactic drainage been utilized in this case, the poor result obtained perhaps might have been avoided.

CASE 3. Uterocervical fistula treated by uterovesical anastomosis. R. P. aged 31 years was admitted to the Israel Zion Hospital August 25, 1924. Four months before admission the patient had had a difficult forceps delivery of a dead fetus with the result that there was a deep laceration through the left angle of the cervix extending up into the broad ligament. This laceration apparently missed the uterine vessel, but involved the left ureter as urinary dribbling followed immediately.

Examination on admission showed a thick scar in the cervix extending up into the base of the broad ligament and urine was observed escaping from the cervical canal.

Cystoscopic examination with ureteral catheterization revealed an impassable obstruction 1.5 inches from the left bladder orifice.

Operative procedure August 27, 1924. An incision was made just above and parallel to Poupert's ligament on the left side. The ureter was identified and separated down to the level of its crossing the uterine artery. The ureter showed no evidence of dilatation, and the point of injury was apparently at that level. The distal end of the ureter was ligated. The proximal end was then implanted into the bladder through a small incision which had been made in the latter viscus for this purpose.

In the week following operation the patient's condition was fairly satisfactory except for a profuse seropurulent discharge of urinous odor through the incision. For 3 weeks thereafter, the patient ran a septic temperature with drainage of pus and urine from the wound. On the twenty-first day after operation there was a profuse hemorrhage from the lower angle of the incision and the patient went into shock. She was taken to the operating room and the wound was explored. It was found that there was extensive retroperitoneal extravasation with free bleeding from a large vessel adjacent to the point of anastomosis. This vessel was ligated, and the wound was cleansed and packed with iodoform gauze. The usual shock treatment was instituted including blood transfusion but was unaiding and the patient expired 2 hours later.

CASE 4. Uterovaginal fistula treated by nephrectomy. G. G. aged 40 years. Hospital No. 2778. Patient was admitted to hospital with fibroid tumor of the uterus. Pelvic examination revealed an irregular hard tumor mass the size of a grape fruit in the fundal portion of the uterus.

On November 25, 1921, panhysterectomy was done.

Urinary leakage was observed from the vagina on the second day after operation. The patient had a stormy convalescence for the next 4 weeks during which time there was considerable discomfort in lower abdomen with intermittent temperature varying from 99 to 103 degrees. Marked frequency and urgency of urination were also present.

The patient was re-admitted to the hospital March 12, 1922. At that time there still was a free leakage of urine from the vagina. Cystoscopic examination revealed that the bladder now practically normal. Ureteral catheter passed without difficulty up the right ureter. On the left side an obstruction was encountered about 1 inch or 1.5 inches from the bladder. The right ureteral orifice was excreting normally with a good functional reaction in 34 minutes. No urine was excreted on the left side.

On vaginal examination urine was observed escaping from the left upper angle of the vaginal vault. The impression recorded on the chart was that there was present a uterovaginal fistula secondary to incomplete section of the ureter at the time of the original hysterectomy.

In view of the poor general condition of the patient, it was considered inadvisable to attempt ureteral anastomosis or implantation of the ureter into the bladder. Therefore a nephrectomy was done March 16. Convalescence following nephrectomy was uneventful. All urinary symptoms gradually disappeared and the patient was discharged April 15, 1922. The family physician reports that at present the patient is in fairly good health with no direct sequelae resulting from her operative complication.

CASE 5. Bilateral ligation treated by deligation. S. S. aged 33 years was admitted to the Israel Zion Hospital November 8, 1920. Following a curettage performed for incomplete abortion the patient went into extreme shock. Accidental perforation of the uterus was suspected. At laparotomy 2 hours later the abdomen was found full of blood-clots from a tear involving almost the entire breadth of the uterus and extending into the left broad ligament. Hysterectomy was performed with marked difficulty because of continuous bleeding from retracted vessels which

TABLE I.—UNILATERAL INJURY TO URETER

I Fistula (causative injury not stated)		
A Ureterovaginal	.. . . .	91
B Uretero-abdominal	.. . . .	8
C Combined ureterovaginal Uretero-abdominal	}	1
II Severed	.. . . .	55
III Resection	.. . . .	13
IV Ligation	.. . . .	18
(One nephrectomy 8 years later for hydronephrosis)		
V Clamped	.. . . .	10
VI Interference with blood supply	.. . . .	6
VII Partially severed	.. . . .	13

bladder was not sufficiently separated from its attachment to the cervix and pushed out of the way, or (2) that one of the sutures was inserted above the level of the reflection of the bladder. In cases in which the bladder seems to be very low I sometimes try to palpate the ureters, but I have never found any case in which they were inserted sufficiently low to be endangered by these deep sutures."

In the 253 cases assembled from the literature, unilateral injuries have been summarized in Table I.

The treatment of this group of cases is illustrated by Table II.

Bilateral injury of the ureters was present in 24 cases. These occurred as complications of the following operative procedures: radical abdominal hysterectomy for carcinoma, 13, radical vaginal hysterectomy for carcinoma, 1, complete hysterectomy for fibroid or pelvic inflammatory disease, 8, bilateral salpingo-oophorectomy for chronic adnexal disease, 2; Percy cautery operation for carcinoma of the cervix, 1.

Bilateral ligation of the ureters occurred in 11 cases, of these, 6 patients were treated by deligation, in 1 case, in which the interval was 48 hours, patient recovered but required a subsequent nephrectomy. Patients in the 5 cases remaining, deligated on the third or fourth day, died. Five patients in whom both ureters had been ligated were treated by nephrostomy. Of these, 2 required subsequent end-to-end anastomosis, 1 necessitated a secondary nephrectomy, and 1 a subsequent implantation of both ureters into the sigmoid. Four of these patients recovered and 1 died. In 1 case of bilateral ligation, no operative procedure was resorted to for relief of the obstruction, and death occurred on the fourth day.

There were 12 cases of bilateral ureterovaginal fistula, of these, 5 closed spontaneously, 3 were successfully treated by colpocelesis. In 3 cases, bilateral ureterovesical implantations were performed with a satisfactory result in all. One pa-

TABLE II.—UNILATERAL CASES

Secondary operation	Number of cases	Recovered	Failure	Deaths	Third operation
1 Ureterovesical anastomosis	61	38† 4	14 2	1	Nephrectomy { 7 cured 2 died
2 Uretero-ureteral anastomosis	23	17	3	3	
3 Nephrectomy	39	37		2	
4 Nephrostomy	3	1		2	
5 Ligation	19	15	2	1	Nephrectomy 1 (cured)
6 X-ray treatment for fistula	20	13	7		Nephrectomy 2 (cured)
7 Mackenrodt operation (ureterovesical implantation vaginal approach)	9	5	3	1	Nephrectomy 2 (cured)
8 Ureterorrhaphy	5	3			Nephrectomy 2 (cured)
9 Ureter implanted in sigmoid	2	1		1	
10 Coagulation of ureteral orifice in bladder	1	1			
11 Ureter anchored to abdominal wall	1*				
12 Splint with catheter	4	3	1		
13 Spontaneous healing without second operation	22	13 9*			
14 No operation	8			3‡ 5 8	
15 Ureteral catheterization	13	10			

*Autonephrectomy

†Fair-moderate stenosis

‡Dead kidney

*Sepsis

tient, on whom a Percy cautery operation had been done, developed gradual obstruction of both ureters, necessitating implantation of both ureters into the bladder. In this case the ultimate outcome was not stated.

TREATMENT

If at the time of operation it is discovered that one or both ureters have been ligated or included in a clamp, the proper treatment is to deligate or remove the clamp promptly. Ordinarily, the ligation around the ureter, or instrumental trauma of the latter, is not sufficient to cause permanent damage. If, however, there is evidence that the vitality of the ureter has been so impaired that a fistula is likely to develop, immediate repair

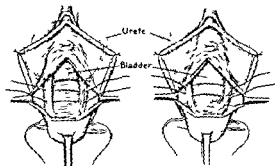


Fig. 4A left Fothergill operation with bladder and ureters mobilized and pushed above range of sutures. Case 8

Fig. 4B Fothergill operation. Bladder insufficiently mobilized. ureters within range of sutures. Case 8

occupying the entire abdominal cavity was found. The operative procedure consisted of supracervical hysterectomy and bilateral salpingo oophorectomy which was attended by great technical difficulties because of the unusual distortion of the anatomy. During the course of the operation the bladder which was densely adherent as a result of the previous low two flap cesarean was accidentally incised. At no time during the operation were the ureters visualized. The perforation in the bladder was repaired and a drain was inserted into the space of Retzius. At the end of the operation a Pezzer catheter was introduced into the bladder *per urethram*. The immediate postoperative course was uneventful except that no urine was expelled through the catheter. After 20 hours of anuria it was suspected that the ureters had been occluded by ligatures.

A cystoscopy was performed and attempts to pass ureteral catheters up to the pelvis of the kidney failed on both sides. Both met with impassable obstructions about 2 inches from the ureteral orifices. Indigo-carminum injected intravenously did not appear from either ureter after 20 minutes.

A right nephrostomy was done at once. The kidney appeared large hydronephrotic and congested. A curved Kelly clamp was thrust into the pelvis of the kidney and a considerable amount of bluish fluid (urine discolored by indigo-carminum) gushed from the wound. A Pezzer catheter was inserted.

The patient was given a direct blood transfusion of 350 cubic centimeters and rallied immediately. For the first 48 hours there was very little secretion through the nephrostomy tube but on the third day a flood of urine was excreted saturating the bed. This profuse drainage continued until the eighth day after operation when bloody fluid of urinous odor was removed from the bladder by catheter. Drainage through the nephrostomy wound decreased to almost nil and the tube was removed on the twelfth day after operation.

The blood chemistry figures in this case were extremely interesting showing enormous nitrogenous retention. On the second day after the nephrostomy and before any urine had appeared the urea nitrogen was 150 and the creatinine 10 milligrams. Two days later with urinary excretion the urea nitrogen was 76 milligrams and the creatinine 4.35 milligrams. Eight days later the urea nitrogen was 17 milligrams.

On the twenty fourth day after operation cystoscopy was done and again both catheters met with obstructions at the same level as before the nephrostomy but the indigo-

carminum was recovered from both sides within 5 minutes after intravenous injection of the dye.

The patient was discharged from the hospital on the thirty fifth day after admission.

In retrospect, the question that arises in this case is whether the ureters had been ligated with catgut and the lumen restored as soon as the catgut was absorbed. It has been shown experimentally that plain catgut is not absorbed before the end of the third week, whereas this patient developed spontaneous restoration of ureteral function 8 days after the nephrostomy. It would appear that the obstruction in this instance may not have been due to encircling ligatures but to kinking and inflammatory swelling on the subsidence of which the ureters opened spontaneously.

CASE 8. Bilateral ligation treated by vaginal dehiscence. F. B. aged 36 years was admitted to the Israel Zion Hospital March 10, 1936.

Operative procedure. Anterior colporrhaphy Fothergill method. The immediate postoperative reaction was good. However during the following 24 hours no urine was excreted through the retention catheter thereby arousing the suspicion of the operator that both ureters had been occluded by the ligatures. At this time a cystoscopic examination revealed the following: Right ureter identified and showed marked edema and pointing. All attempts to pass a ureteral catheter into the orifice were unsuccessful due to edema. The same condition was found on the left side. It is believed that the edema is secondary to ligation of the ureters higher up. Following intravenous indigo-carminum no dye appeared in the bladder after 30 minutes.

An immediate dehiscence from below was decided upon. The repaired anterior perineal wall was reopened and the superficial sutures were incised the three interrupted sutures approximating the lateral pubocervical tissues (bladder pillars) being laid bare. All three sutures were cut thus revealing the uppermost of the three to be the culprit. The area thus freed was packed with iodoform gauze and the mucous membrane approximated with continuous locked sutures of chromic catgut. A cystoscope was then introduced into the bladder and a No. 4 F catheter met with obstruction on both sides about 4 centimeters from the bladder (probable point of ligation) with great difficulty this obstruction was overcome and both catheters were passed up to the level of the kidney pelvis. Urine immediately returned from both sides and it was tugged with the blue dye the catheters were left *in situ* for drainage. In the next 24 hours 32 ounces of urine was excreted through the catheters. The ureteral catheters were then removed and the patient was catheterized at intervals of 6 hours for the next 5 days. On the seventh day after operation the patient voided spontaneously and from that time on the convalescence was uneventful.

Fortunately this type of injury as a complication of anterior colporrhaphy is extremely rare. This is confirmed by a personal communication from Dr. William Fletcher Shaw of Manchester who writes: "In this city we do some hundreds of this operation every year and have done so for the last 30 or 40 years and I have never known a case in which even one ureter was tied. I can only suggest that this accident occurred because (1) the

THE ALBEE SPINE FUSION OPERATION IN THE TREATMENT OF SCOLIOSIS

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IN SPITE of the many years it has challenged the ingenuity of orthopedic surgeons, the treatment of idiopathic scoliosis is still on an uncertain basis in many centers. The number of failures encountered in consultation practice and the variety of therapeutic procedures devised confirm this conviction. The problem of scoliosis has been characterized as one of the stumbling blocks of the orthopedic surgeon. In attempting to unearth the causative factors in this situation, the senior author feels that a critical survey of the therapy of scoliosis is warranted. The extensive experience gained in the operative treatment of diseases and deformities of the spine during a period of more than 25 years forces him to indict certain therapeutic regimens as having unsound bases. Many of these cases were especially instructive because of previous abortive attempts at treatment, particularly the injudicious employment of braces and plaster jackets. Their application seriously interferes later with a satisfactory realignment of the spine by surgical means. Unfortunately, the offending structures in early idiopathic scoliosis—the muscles, tendons, and ligaments—are weakened by suppression of the stimulus of function. It must be realized that in treating curvatures with a brace, one attempts to correct the spine indirectly through pressure on the thorax. The ribs are elastic structures and a great deal of the force exerted will be merely spent on increasing their angulation, or changing the relations at the costal vertebral joints. When the brace is removed, the spine collapses, as Whitman aptly put it, like an abandoned accordion. Obviously, to remove the brace is to court disaster and both patient and the physician will cling to it like the proverbial drowning man. Figure 3b is illustrative of such a catastrophe. Figure 1, patient A.N., reveals rapid progress of curvature after 1 year in a plaster jacket. Furthermore, the utilization of a brace in a mild case will often weaken the soft structures, increase the angle of deviation, and set up a vicious cycle converting a non-progressive spine to one requiring operative correction.

From the Florida Medical Center. Fred H. Albee, medical director.

Treatment by corrective medical gymnastics is rational therapy in early idiopathic cases. Curvature is overcome by strengthening, not undermining, the mainstays of the spine. Early non-progressive cases are easily eliminated. Our position in regard to operation is this: Corrective medical gymnastics without braces are carried on with periodical check up by trunk x-rays, which we find the most trustworthy method of recording the lesion. As soon as it is realized that the spine shows a tendency to increasing deformity, in spite of conservative treatment, operative stabilization of the spine is recommended. In the early days before the employment of the bone graft, such cases were almost a "nightmare" to the surgeon as he was compelled to see the most pronounced deformities develop right under his eyes and his hands were completely tied as to prevention. The operative treatment has proved a great satisfaction.

The Albee extra-articular arthrodesis as first conceived in 1908, was evolved from fundamentally sound biomechanical and physiological principles. That these were correct was attested to recently by the appearance of a patient whose spine had been fused a quarter of a century ago. He is pursuing an active and useful life today, as first officer on a transatlantic steamer. Although the profession was quick to adopt the operation in the treatment of Pott's disease and abandon conservative therapy, there has been a marked hesitancy to follow a similar course in the therapy of scoliosis. Steindler (7), after a large practice states "In the light of the experience made with all methods of scoliosis treatment, one is justified in saying that operative fusion, while at this time accepted as a temporary solution, does not entirely solve the problem. In the advanced deformities of non-compensated cases, it will be the only refuge, and we owe a debt of gratitude to those who have developed the method and perfected its technique." This apparently sums up the attitude of the profession in general.

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should be done in the form of uretero-ureteral or ureterovesical anastomosis

Where both ureters have been ligated and it is not discovered until the following day or later, the condition is a serious one. The combination of complete anuria and threatening uremia makes immediate surgical intervention imperative. The three alternative procedures to be considered are deligation of the ligated ureter, nephrostomy, ureterovesical anastomosis

CONCLUSIONS

1 From the large number of cases of ureteral damage recorded in this paper, it is evident that the accident is a surgical complication far more common than is generally assumed

2 It is quite likely that a certain number of unilateral ligations occur during the course of pelvic operations which are not recognized and which do not provoke immediate symptoms, with ultimate autonephrectomy on the corresponding side

3 This accident may be sustained during any pelvic operation but it is more common following radical abdominal or vaginal hysterectomy and notably in operative procedures for the removal of intraligamentous tumors. In selected cases in this group, catheters may be inserted into the urethra before the operation is started as an additional safeguard

4 The majority of cases are those of unilateral injury, more rarely both sides are involved, the proportion being 6 to 1

5 As an index of the seriousness of ureteral injury, may be mentioned the mortality figures quoted by Bland of 33.3 per cent for the bilateral and 18.8 per cent for the unilateral cases

6 The most common sequelæ of ureteral injury are vaginal and abdominal fistulas

7 If the ureter is divided during the course of a hazardous or markedly prolonged operation the operator may be compelled to resort to ureteral ligation, but this is justifiable only when the risk of reparative procedure for the restitution of function of the injured ureter appears too great

8 If a ligature or clamp has been placed on either one or both ureters and the injury is detected at the time it is inflicted and there is evidence that the vitality of the ureter has been so impaired that fistula is likely to develop, immediate repair should be done in the form of uretero-ureteral or ureterovesical anastomosis

9 In the case of bilateral occlusion, discovered after operation with imminent danger of uremia immediate deligation is the operation of choice, provided the patient's condition is such that she can endure this hazardous and time consuming operation

10 Nephrostomy may be the most feasible procedure when intra abdominal work is contraindicated by gravity of patient's condition. This drainage should preferably be bilateral

11 In view of our results of 100 per cent mortality with two intra abdominal deligations the writer feels that nephrostomy with subsequent operation for ureteral anastomosis or bladder implantation, when found necessary is a much safer and, therefore, a preferable procedure

12 Finally, the operator, when confronted with a damaged ureter, should be prompted in his selection of the reparative procedure with the fundamental aim in mind of the preservation of both ureteral and kidney function

The author is indebted to the members of the staff who permitted him to utilize the records of their private patients as part of this study, and he gratefully acknowledges the co-operation of Dr Maxwell Dorr and Dr Harry Ehrlich for their assistance in assembling the preliminary data. He also desires to express his appreciation of the assistance given him in the completion of this survey by the Literary Research Department of the American College of Surgeons

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THE ALBEE SPINE FUSION OPERATION IN THE TREATMENT OF SCOLIOSIS

FRED H. ALBEE, M.D., Sc.D., LL.D., F.A.C.S., and ALEXANDER KUSHNER, B.Sc., M.D.,
Venice, Florida

IN SPITE of the many years it has challenged the ingenuity of orthopedic surgeons, the treatment of idiopathic scoliosis is still on an uncertain basis in many centers. The number of failures encountered in consultation practice and the variety of therapeutic procedures devised confirm this conviction. The problem of scoliosis has been characterized as one of the stumbling blocks of the orthopedic surgeon. In attempting to unearth the causative factors in this situation, the senior author feels that a critical survey of the therapy of scoliosis is warranted. The extensive experience gained in the operative treatment of diseases and deformities of the spine during a period of more than 25 years forces him to indict certain therapeutic regimens as having unsound bases. Many of these cases were especially instructive because of previous abortive attempts at treatment, particularly the injudicious employment of braces and plaster jackets. Their application seriously interferes later with a satisfactory realignment of the spine by surgical means. Unfortunately, the offending structures in early idiopathic scoliosis,—the muscles, tendons, and ligaments—are weakened by suppression of the stimulus of function. It must be realized that in treating curvatures with a brace, one attempts to correct the spine indirectly through pressure on the thorax. The ribs are elastic structures and a great deal of the force exerted will be merely spent on increasing their angulation, or changing the relations at the costal vertebral joints. When the brace is removed, the spine collapses, as Whitman aptly put it, like an abandoned accordion. Obviously, to remove the brace is to court disaster and both patient and the physician will cling to it like the proverbial drowning man. Figure 3b is illustrative of such a catastrophe. Figure 1, patient A.N., reveals rapid progress of curvature after 1 year in a plaster jacket. Furthermore, the utilization of a brace in a mild case will often weaken the soft structures, increase the angle of deviation, and set up a vicious cycle converting a non-progressive spine to one requiring operative correction.

Treatment by corrective medical gymnastics is rational therapy in early idiopathic cases. Curvature is overcome by strengthening, not undermining, the mainstays of the spine. Early non-progressive cases are easily eliminated. Our position in regard to operation is this. Corrective medical gymnastics without braces are carried on with periodical check up by trunk x-rays, which we find the most trustworthy method of recording the lesion. As soon as it is realized that the spine shows a tendency to increasing deformity, in spite of conservative treatment, operative stabilization of the spine is recommended. In the early days before the employment of the bone graft, such cases were almost a "nightmare" to the surgeon as he was compelled to see the most pronounced deformities develop right under his eyes and his hands were completely tied as to prevention. The operative treatment has proved a great satisfaction.

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Fig 1 a left Patient A N Idiopathic scoliosis Spine at onset of treatment. b After wearing plaster of Paris jacket constantly for 1 year

obtained by the Risser cast. Operation is performed through a window cut through the plaster cast over the area of primary curvature to be fused. The cast is retained for 3 months and physiotherapy is then instituted. If the area of spine involved be extensive, then a second cast is applied, correction is accomplished with a turnbuckle, and a second bone graft is inlaid into the secondary curvature. Thus in early cases arrest may be reached in 4 months and in decompensated spines in 8 months. Except in the most advanced ones, if the primary curve is fused then, the secondary responds to the correction. Control of the primary is usually sufficient. Second operation is necessary in only about 10 per cent of cases.

Figure 2 illustrates the various procedures. The lower pole of graft B was interlocked with the upper end of A at C, welding the unstable chain of articulations into a solid bar of bone. An increase in height of several inches is often noted as a result of opening up the curve with turnbuckle and hinged cast before operation. This method of realignment by an eccentric hinge and turnbuckle brings a powerful force to bear upon the curvature. Jackets designed to apply corrective compression to apex of curve are constructed contrary to the engineering principle of the key stone constituting the strongest part of the arch.

THE PROP GRAFT

Patient E P presented an interesting problem in treatment. Her curvature was of such a

degree that her ribs had telescoped into the pelvis producing painful symptoms with locomotion (see Fig 3 a and b). The soft structures on the concave side had so contracted after prolonged conservative therapy that it was found impossible even by applying excessive force with the turnbuckle to secure a satisfactory correction. Accordingly it was decided to extract the ribs from the pelvis at operation and prevent their prolapse by interposing a stout prop bone graft between the ilium and tenth rib to augment the spinal inlay graft with cross grafts at central portion of curvature (see Figs 4 and 5). The prop graft must be carefully mortised into the tenth rib, as shown in Figure 5, to prevent it from slipping past into the pleural cavity. The graft is tunneled through muscle planes as it is always desirable to provide for an adequate blood supply. Grafts should never be placed in an avascular environment such as fat or scar tissue. During convalescence the patient displayed excessive zeal in developing her musculature and fractured the strut graft. Happily, a pseudarthrosis developed at the fracture site (1, Fig 4), and thus there resulted a new articulation in the evolution of man. This structure permits articulation between the ilium and thoracic cage and removes any restriction of motion that absolute fixation may have occasioned. It is in this type of spine that the bone graft meets its supreme test and to judge its worth one has only to listen to the enthusiastic comment of patients and parents.



Fig 2 a, Same as Figure 1 Correction of lumbodorsal curve with turnbuckle and hinged cast Turnbuckle not visualized Compare with Figure 1b b, Roentgenograms showing permanent fusion of lumbodorsal spine by means of bone graft, A, to prevent recurrence Correction of dorsal curve by turnbuckle Patient ready for second

Albee fusion. c, Roentgenogram taken 5 months after second fusion operation The lower pole of graft B was interlocked with upper pole of graft A at C so as to abolish articulation, construct an unyielding bony ridge, and as well to insure permanent correction Note hypertrophy of graft A

That the graft retains its vitality is proved by its permanency in cases of over 18 years' duration. To those clinicians who regard the graft as an osteogenetic scaffold for osteoblasts to make their way from ilium and pelvis and meet in the center, we would point out there is no confirmation—clinically or experimentally—for such a stand The graft retains its vitality and advertises this fact by its ability to produce callus when fractured, or enter into the formation of pseudarthrosis as noted in Figure 4

The routine employment of spine fusion without a tibial graft in early cases has been opposed chiefly because of the magnitude of the operation and the uncertainty of fusion We admit that these criticisms are justified after noting that Brogden reports failure of fusion in 47 per cent of patients operated on at the Hospital for Ruptured and Crippled when done according to the Hibbs method Steindler (7) reports "the so called break or false motion in a fused spine is very frequent" after the Hibbs fusion Gaenslen remarks "to those who have done the Hibbs operation, it will be quite apparent that it is a difficult matter to get anything like a continuous periosteal tunnel by denudation of the lamina . It is extremely

difficult to carry out fusion on one side, especially when one considers that just one break in the operative procedure, such as missing a single set of articular facets, may jeopardize the entire operation'

With such poor results from the hands of competent orthopedic surgeons, there can be no doubt that the Hibbs operation is unsuited for scoliotic spines The chain of arthrodesed articulations is no stronger than its weakest link When marked rotation of the vertebræ has occurred, many of the articulations are inaccessible. The mechanical basis of the operation is incorrect. Fracture of the spinous processes tends to encourage further flexion and rotation The center of gravity passes anterior to the bodies of the vertebræ in the dorsal region and the tendency of the spine to forward flexion is counteracted by ligamentous structures attached to the spinous processes—the ligamenta interspinale and supraspinale Furthermore, there are important muscle attachments to this structure—the multifidus, semispinalis, and sacrospinalis groups Denuding and fracturing the processes, by releasing the favorable action of these ligaments and muscles tends to encourage rather than correct further



Fig. 3 a left Patient E.P. Idiopathic scoliosis. Spine at onset of conservative therapy b Corkscrew spine after prolonged treatment by corrective exercises, braces, plaster jackets and traction

deformity. Complete immobilization is disturbed by the slight motion transmitted to the vertebrae by the costovertebral ligaments during the respiratory excursion of the ribs. The extended period of postoperative traction on a Bradford frame followed by plaster cast and brace for 1½ years does not invite recourse to surgery. A minor point but of clinical importance is the fact that the x ray picture may not be of any assistance in determining whether or not fusion has been obtained. The superimposition of the shadows of potential areas of arthrodesis make this unlikely. Figure 6 is a case in point. The patient had been subjected to a Hibbs fusion and complained of pain with inspiration and motion—where none had previously existed. The x ray film did not furnish any clues as to the localization of the pseudarthrosis, which was subsequently disclosed at operation. A tibial graft was inlaid at the break and complete relief was obtained. The authors wish to tarry upon this as an undisputed fact—that presence of pain is indicative of interruption of fusion. Pain is associated with muscle spasm when fusion has been attempted and failed. This superadded spasm tends to increase deformity. In other words the *modus operandi* of the rapid increase of the distortion is due to induced pain and its resultant muscle spasm upon an unbalanced musculature. Finally the operating time of 1 to 1½ hours is a major drawback when one considers the

paucity of reserve that some of these patients possess.

The Albee operation offers a technique calculated to encourage corrective biomechanics and mobilizes the maximum osteogenicity of vertebral bone. The tibial graft is an active osteogenetic brace which re-enforces itself by proliferation of bone at points of greatest stress according to Wolff's law. In regard to this an interesting phenomenon has been observed. We have noted that when the graft was implanted nearer the tip of the spinous process fusion occurred earlier and proliferation of bone was greatest. This is entirely in keeping with the mechanics of the operation. The spinous process is the arm of a lever the fulcrum of which is the intervertebral articulation. Therefore the tip of the process is subject to the maximum stress or vice versa the greatest corrective effort should be applied at the greatest distance from the fulcrum, i.e. at the tip. Practically this is not always possible. However the potential leverage of the spinous process is almost always available and is utilized to its maximum extent in the Albee operation.

A study of the trabecular system of a vertebra will elucidate this conception (Fig. 7). Translated into mechanical terms the significance of these systems is as follows. The vertebrae manifest a more passive function in the body and a more active function in their processes.



Fig 4 Same as Figure 3 Four years after operation showing bone graft holding securely the corrected position of ribs after they were extracted from the pelvis at operation Union with tenth rib at A Note increased density of tenth rib—also hypertrophy of spinal graft Full correction not attained because of extreme contracture of soft tissues on concave side following extended conservative therapy This patient indulges in the most strenuous of exercises, including skating and tennis

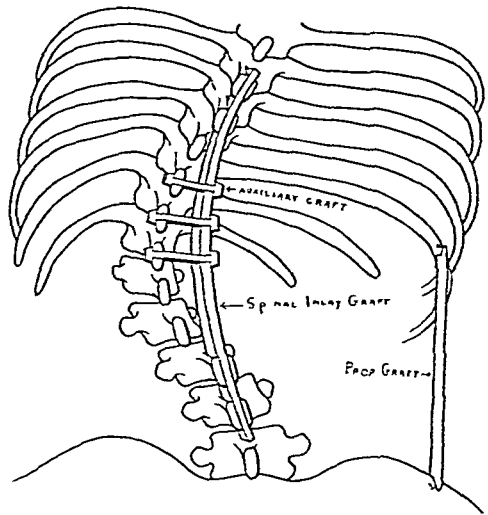


Fig 5 Schematic representation of prop graft (Fig. 4) Note interlocking of graft and tenth rib, also auxiliary grafts at right angle to spinal graft, necessary in extreme degrees of curvature

The body principally sustains pressure while the apophyses or processes are levers for the application of muscle force Thus, when the process is fractured at its base, important ligamentous and muscular tension stresses are disturbed, so that the fusion obtained is unable to cope with the severe strain of the superincumbent weight and pseudarthrosis will result in almost 50 per cent of fusions attempted in the lumbodorsal region, in spite of the supporting brace (Steindler)

The graft should cover 7 to 8, or sufficient vertebrae so that the upper and lower poles will contact processes the vertebrae of which have not rotated to the degree present at the apex of the curve In this way, a forceful derotating as well as straightening influence will be exerted on the intermediate vertebrae, and a corrective force brought to bear directly on the vertebrae In contrast to the insertion of the graft for purely anteroposterior curvatures such as Pott's disease in which the graft is put in edgewise, it is important in this instance to put it into the split spinous processes and their embedding ligaments flatwise, so that its maximum strength can be used as an internal lever and splint still further to force the spine into alinement beyond that secured by the turnbuckle plaster jackets We regard this as an outstanding feature of the operation In extreme degrees of curvature, it may be necessary to shortcut several vertebrae because

of the impossibility of obtaining a graft of sufficiently acute curve. They may be controlled by placing several auxiliary grafts at right angles from the main graft to the spinous processes of the central vertebrae into which the main graft cannot be inlaid because of inadequate curvature. In this instance, the spinous processes are split longitudinally but crosswise to receive one end of the auxiliary graft while the other ends are contacted with the main graft. This was necessary in our patient. E P. (Figs 4 and 5). The graft functions as a prop in this type of case and tends to be compressed between the bases of the arch This is a favorable stress for the graft and maximum proliferation occurs

An analysis of the divers stresses and strains that the graft is subjected to in different areas of the spine and its response to these offers an interesting study. Our investigation along these lines will be published at a later date.

The inferior osteogenicity of vertebral bone was demonstrated by Albee (1) in 1908, by animal experiments This is readily confirmed by the surgeon who relies entirely on such bone for fusion. Furthermore, it will become quite evident when the statistics concerning the failure of repair of vertebral fractures are studied, and particularly those of the transverse processes Although lying wholly within muscle, when broken and not displaced, they unite in less than 5 per cent of cases Spies states, in his studies of



Fig 6



Fig 8



Fig 9

Fig 6 Non fusion in spine after Hibbs operation demonstrating difficulty of localizing break. Onset of pain which did not exist before operation indicated failure of fusion—confirmed at operation. In three locations fusion had failed to take place but roentgenograms failed to disclose interruptions of fusion for the reason that the shadows of the bony elements were superimposed upon each other.

Fig 8 Patient R H Excellent visualization of graft in lateral roentgenogram. This is of considerable aid to the surgeon in evaluating the progress and permanency of bony fusion.

Fig 9 Patient L A This roentgenogram taken 24 years after the spinal graft was inserted has not yielded to the early tendency to progression—convincing evidence of the permanent corrective influence of the tibial graft.

an extensive number of cases of fractured articular processes, that they practically never unite. Likewise the progress of union in fractures of the spinous processes is very poor. Willis has offered an embryological explanation. He states that vertebral bone together with the cerebrospinal

system is derived principally from the ectoderm and that ectodermal tissue such as spinal nerves, have a low degree of reparative potentiality. This is a distinct contrast to mesodermic tissues such as skeletal bones including the tibia, which exhibit a high degree of osteogenesis.

Because of this inadequate callus forming capability of vertebral bone it is clear that in order to secure a strong fusion, a single graft from a long bone of high osteogenicity should be used to supplement that of the local vertebrae. The tibia fortunately for the purpose of the reconstruction surgeon inherently has not only great osteogenetic potentiality and excellent reparative power but great strength. When inlaid into the spinous processes it not only serves as an excellent corrective internal immobilization splint but immediately fuses by its own osteogenetic influence and that of the spinous processes themselves with the spinal column. When one considers the wide limits of variations inherent in different individuals in regard to vertebral osteogenicity it becomes incumbent upon the surgeon

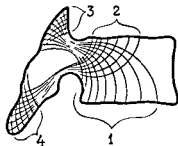


Fig 7 Architecture of vertebra illustrating different and distinct systems of trabeculae. The graft is inlaid and exerts its stress through system 4 thereby obtaining maximum leverage and corrective influence. (After Gallis and Japet)

to play the game as safely as possible and select not only an ample amount of bone in the form of a complete splint, but bone of the greatest known osteogenetic potentiality. To rely on the low osteogenetic potentialities of vertebræ, particularly in the form of chips, is to gamble on getting a favorable outcome instead of being practically certain of it (2).

In analyzing the vertebral bone chip operation, we mentioned the difficulty in following the progress of fusion by means of the x-ray picture. After the tibial bone graft operation, the x-ray is invaluable in this respect. Figure 8 demonstrates the excellent visualization of the bony bridge.

An important consideration when deciding treatment is the length of time required for an operation and the shock occasioned by it. An operation that consumes little time and induces comparatively little shock may obviously be undertaken when the surgical resistance of the patient is not of the best. The bone graft operation has been completed in as little as 9 minutes, in a favorable case of Pott's disease, if one's operating team is thoroughly familiar with the routine and the special instruments used. The technique does not require excessive retraction and there is no necessity to operate more or less blindly in regions difficult of access (3).

Postoperative care consists of 3 months in the turnbuckle cast, followed by physiotherapy. In severe cases, a modified Knight spinal brace is fitted and utilized until the x-ray discloses a firm bony bridge of large diameter.

Modifications in the method not in accord with these principles diminish its efficiency and unjustly bring it into disrepute. It cannot be satisfactorily combined with the Hibbs technique because the spinous processes should not be cut off. Osteoperiosteal grafts are too frail to obtain any immediate immobilization. Heterogenous grafts are biologically unsound and are to be condemned. In the series quoted above, Brogden reported non-fusion in 66 per cent of patients operated upon according to the Hibbs method, re-enforced by beef bone grafts. Rib grafts do not have the osteogenicity of the tibial grafts and do not lend themselves to being shaped as the strength depending on the thin cortical tubular form is lost. Their structure is too elastic to be able to exert the proper stress required.

Preston, after a careful study of the literature, comments "It is evident that some form of operative treatment is thought necessary for all cases which cannot be easily controlled by exercise. Widespread dissatisfaction with the results of fusion operations which do not utilize some

form of internal splint is shown by the large number of new procedures reported, most of which are modifications of the Albee technique. Many of them are mechanically unsound because either the firm anchorage of the graft is destroyed or the internal splint itself is composed of a substance which soon disintegrates."

This communication is based upon 518 cases over a period of 26 years. In 7 cases, the spinal supportive graft or grafts have been supplemented by a costal pelvis prop. The anterior end of the tenth rib has been selected as the point at which to affix the tibial graft. These ribs, rather than one of the lower ones, have been selected because they are more firmly anchored to the thoracic cage and will therefore transmit the corrective influence directly to the spine. X-ray films of cases taken over 20 years after operation disclose that grafts maintain their conformation and do not yield to the extensive pressure which they have often withstood for so long a time. Even after many years their stabilizing and corrective influence continues.

SUMMARY

The bone graft is of the greatest aid to the surgeon in the following manner:

1. The leverage and splintage action of the graft is exerted directly upon the vertebræ themselves at the curvature.
2. The graft is subject to a favorable stress in scoliosis and exhibits remarkable hypertrophy.
3. The graft lends itself to x-ray study in establishing progress and permanency of fusion.
4. The graft adds more bone when it is urgently needed; the bone in the spinous processes of thoracic region of spine is insufficient.
5. The graft brings a rapid callus producing bone into a low osteogenetic area.
6. Fusion after the curve is opened up or partially straightened often increases the height of the patient by several inches.

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PRIMARY FIBROBLASTIC TUMORS OF THE CHOROID PLEXUS OF THE LATERAL VENTRICLES

A Clinicopathological Study of Three Cases

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P RIMARY benign intraventricular tumors are uncommon and, with few exceptions, the literature consists of scattered reports of single cases. Dandy (4) states that they constitute about 0.75 per cent of all brain tumors. While this number is exceedingly small, certain clinical and pathological findings related to these tumors make them of interest.

The recognition of primary benign intraventricular tumors by clinical means is practically impossible. Usually associated with marked increase of intracranial pressure, these tumors produce signs which, as a group, point to no specific area of the brain but may occasionally cause neurological changes which direct attention to several widely separated cerebral areas. Thus the symptoms and signs are apt to be quite confusing. However, with the advent of pneumographic studies as an aid to the localization of intracranial growths, the absence of localizing phenomena has come to be of less serious consequence than formerly.

From the standpoint of the biohistory and histological character of the tumors, the prognosis for the patient is excellent, but the large size which these tumors attain and the trauma which is concomitant with their removal makes this a hazardous procedure. The study of the pathology of this group of tumors has been neglected to a great degree. As Davis and Cushing have stated, there is a tendency in the literature to describe in one category a great variety of lesions which protrude into the ventricle and to assume, without accurate histological evidence, that they actually have originated from the adjacent plexus.

The 3 following cases are of interest both from the clinical and pathological standpoints. The diagnostic difficulties have already been referred to and the fact that all three tumors are primary fibroblastomas which arose, without reasonable doubt, from the choroid plexus or tela choroidea makes them worthy of consideration.

REPORT OF CASES

Case 1. The patient, a 36 year old white man, entered the hospital in September, 1927, complaining of severe headaches, nervousness, loss of memory and staggering gait. About 6 weeks before admission he had experienced a severe headache which had lasted for about 6 hours. Two weeks later he had an attack of faintness which had lasted but a few minutes. Following these episodes he became very nervous, somewhat unsteady in walking, developed and he had lost confidence in himself. Drowsiness had been present since the beginning of the year, but there had been no nausea or vomiting. For 3 weeks previous to admission the patient had himself noticed a failing memory and for the past 10 days the headache which had been most marked over the vertex had become almost constant. No history of failing vision, sensory or motor defect was elicited nor had there been diplopia or tinnitus.

Neurological examination revealed little at that time. There was a slight bilateral exophthalmos, some decreased auditory acuity on the right side and a slight amount of ataxia. Motor and sensory defects were absent. The optic discs appeared normal. Subjectively there was a loss of memory and some dizziness. Arrangements for the administration of lumbar fluid was instituted and the patient was told to report at regular intervals for further observation.

Repeated spinal punctures during the subsequent interval revealed normal fluid dynamics but some xanthochromia. However, after 2 months the patient began to show definite signs of an expanding intracranial lesion. He was found to be mentally dull and he had almost total motor aphasia. There was slight edema of both optic discs, but definite choking was absent. Bilateral exophthalmos was present. Marked hypertonicity was present over the entire right side and the Babinski sign was present bilaterally. There had been a transient paralysis of the right lower part of the face and the headaches had become more severe.

In November, 1927, in the hope of finding a removable growth, an osteoplastic flap was reflected in the left temporoparietal region. The exploring brain cannula localized a deep seated tumor. The wound was closed leaving a decompression without an attempt at removal of growth. After a somewhat stormy course, patient was discharged with little improvement over his former condition. Subsequent therapy with filtered x-rays was followed by considerable improvement and he was practically symptom free up to the time of the second admission in July, 1930—32 months after operation.

Two days previous to the second admission the patient had experienced a generalized convulsion in his sleep but aside from a rather sluggish mentality and a slightly drawing speech there was nothing to suggest a cerebral lesion. Lencephalography was advised in the hope of localizing a cyst which could be drained. Roentgen examination (Fig. 1) gave evidence of a large tumor obstructing the posterior portion of the body of the ventricle in the left occipitoparietal region.



Fig 1 Encephalogram The outlines of the previous bone flap and decompression are evident There is dilatation of the right ventricle The left ventricle is obstructed so that only the anterior half of the body is visualized Case 1

Under avertin ether anesthesia, a left occipital craniotomy was performed. Cannula exploration yielded 3 to 4 cubic centimeters of yellow coagulable fluid at a depth of about 3 centimeters. An incision into the cortex exposed an encapsulated tumor which apparently was confined to the posterior portion of the left ventricle. An immediate biopsy was reported as possibly a fibroblastoma. Since piece-meal removal with the electric loop caused marked bleeding, the growth was removed by finger-enucleation after a preliminary transfusion. The tumor came away in two pieces and this was followed by sharp bleeding from its anterior attachment which was well forward on the mesial wall of the lateral ventricle. The anterior limit of the growth was almost as far forward as the foramen of Monro. This anterior portion was much more firm and much more nodular than the posterior portion and was thought to be the older part of the neoplasm.

Although the immediate response after operation was surprisingly good, the subsequent course was consistently downhill. An encephalogram made 10 days after operation showed that the symmetry of the ventricles was restored and there was no evidence of a clot. The patient died 5 weeks after operation. No autopsy was granted.

Pathological description The total weight of the tumor was 135 grams. The largest piece measured approximately 6 by 5 by 5 centimeters and was grayish-white, soft, and rather friable. A scanty capsule covered the surface. The cut surface appeared slightly granular and without whorl formation. A smaller piece was somewhat firmer and rather nodular, but differed in no significant way from the above.

Sections of the tumor were stained with hematoxylin and eosin, Mallory's phosphotungstic acid hematoxylin, Weigert's resorcin-fuchsin for elastic tissue, Wilder's silver impregnation for reticulum, Mallory's anilin blue orange G, acid fuchsin, and Perdrau's silver impregnation for connective tissue. Poor staining quality interfered to some

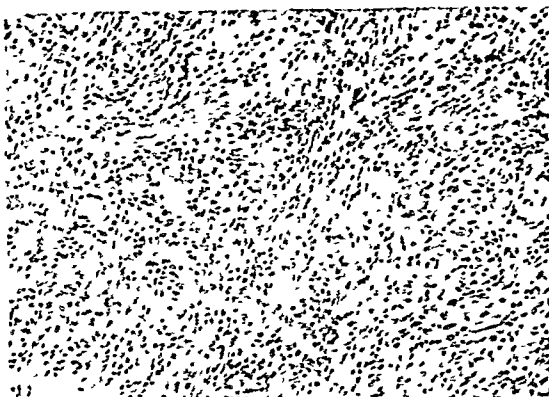


Fig 2 Section of tumor Note the indefinite cell boundaries and the abundance of intercellular collagenous material Case 1 (Hematoxylin and eosin $\times 120$)

extent with the histological examination of the specimen.

Microscopically, there is present a rather thin capsule composed of moderately dense collagenous connective tissue containing numerous small, thin walled vessels. The tumor tissue is quite cellular and with some disposition toward whorl formation, although this is not marked in all parts of the tumor. The individual cells have moderately small, round or oval, vacuolated nuclei which contain a relatively small amount of chromatin material in the form of coarse granules. Several nucleoli are usually present and the nuclear membrane is fairly distinct. There is a fair amount of finely granular cytoplasm which tends to be bipolar in distribution, although cytoplasmic boundaries are quite indistinct and often invisible. Intercellular material is quite abundant and, although the tumor appears densely fibrous, a definite reticulum is not present (Fig 2). However, about the vessels in the immediate surrounding tumor tissue, there are small collections of fine fibrils which appear to have their origin from the vessel walls. There are numerous thin walled vessels and occasional large vessels both of which are filled with moderately well preserved blood.

Where whorl formation is marked, hyalinization is often present and a few well formed calcospheres are evident. Fibroglia fibers were not demonstrated by the special stains although it is possible that the poor state of preservation of the tissue interfered with the staining of these. Pleomorphism is not marked, although occasional cells contain several nuclei and cells with large, round, swollen atypical nuclei can be found. Scattered throughout the tissue are numerous round cells and in a few places these appear as focal collections. Areas of degeneration, although present, are not particularly common and not very extensive.

The tumor is regarded as a fibroblastoma.

CASE 2 A patient a 26 year old white man, was admitted to the hospital in May, 1932, complaining of ataxia, headaches, spontaneous vomiting and drowsiness. The patient at the time of admission was stuporous and it was necessary to obtain most of the history from his wife.

Headache of mild severity had been present for 5 years. About 9 months prior to admission, the headaches had increased in severity and spontaneous vomiting had begun. For about 3 months the patient had complained of attacks of pain which were localized to the upper cervical region. These lasted from 15 minutes to 1 hour and necessitated sitting with the neck bowed and the chin resting on the



Fig. 3. Photomicrograph of tumor. Note evident fibroblastic character of the cells. Case 2. (Hematoxylin and eosin $\times 187$)

sternum. About 6 weeks before admission the patient had been hospitalized elsewhere for observation and at that time ataxia with staggering to the right had been noted. For 5 days prior to the first hospitalization there had been marked drowsiness and regurgitation of food through the nose had prevented him from obtaining much nourishment.

Neurological examination gave definite evidence of an expanding intracranial growth although localization was uncertain. There were bilateral choked discs with edema of one disc on the right and two discopons on the left. The left pupil was fixed to light and although a definite nystagmus was absent, short nystagmoid jerks were present when the patient fixed the eyes to the left. A partial lower facial paralysis was present on the right and there was generalized muscular weakness most marked in the right arm and leg. Sensation was normal throughout. Ataxia was present and the Romberg test was positive, the tendency being to fall to the right. Moderate bilateral adiadochocinesia was present also. The abdominal reflexes were absent and the gag reflex was impaired. The posture causing the patient the least discomfort was with the head bent forward and the chin resting on the chest. Perimetry could not be carried out. Roentgenograms of the skull gave evidence of long standing increased pressure. There was atrophy of the dorsum sellae and clinoid processes with erosion of the floor of the sella turcica.

Ventriculograms taken on the third hospital day showed the air present only in the posterior portion of the right ventricle and this was dislocated to the right. The ventriculographic diagnosis was tumor of the left frontal lobe.

Left frontal craniotomy was performed following ventriculography. The exposed brain was tense but otherwise normal in appearance. Incision into the brain exposed the outer surface of a firm, encapsulated tumor confined within the anterior horn of the left lateral ventricle. After considerable difficulty the tumor was removed in two large pieces. Free bleeding occurred from the tumor bed, the blood coming from the vessels of the choroid plexus about the foramen of Monro.

Following a stormy postoperative course in which infection complicated recovery, the patient was discharged on the forty-fifth hospital day. He was readmitted 2 months later complaining of drowsiness, weakness and projectile vomiting. Neurologic examination was essentially negative but in view of a previous infection and the presence of a high spinal fluid cell count, exploration for a cerebral



Fig. 4. Pre-operative ventriculogram. There is marked dilatation of the right ventricle. In the left ventricle there is an obstruction at about the midpoint of the body so that only the anterior portion and the occipital horn is visualized. Case 3.

abscess was carried out. No lesion was discovered and subsequent ventriculographic studies revealed nothing abnormal aside from the presence of a moderate dilatation of the ventricles. The patient was discharged on the seventh hospital day with considerable improvement in his condition. He died, however, 1 month later. No autopsy was granted.

Pathological description. The weight of the two large tumor masses was 100 grams. The larger measured 7 by 5.5 by 5.5 centimeters and with the exception of one surface which was cut across in removal, the tumor was covered by a smooth, thin, glistening capsule in which numerous veins were visible. The surface was irregular with numerous large bosses. Sections through the tumor mass revealed a uniformly white, somewhat granular surface with numerous areas of recent hemorrhage. No cysts were present and gross calcification was not observed. The smaller mass weighed 45 grams and measured 4.5 by 4 by 1.5 centimeters. The tissue was similar to that of the larger mass but due to the presence of more diffuse hemorrhage its color was grayish red.

Tissue taken from various portions of the tumor was stained by the methods listed previously. Here again the staining quality of the tissue interfered with the microscopic study of the growth.

Microscopically there is a thin capsule composed of loosely woven connective tissue in which numerous large and small vessels are present. The cells are arranged in sheets and although the first impression is one of marked streaming and parallelism, close examination reveals the fact that this picture is due to the peculiar type of chromatin present. The individual tumor cells are small, round or elongated and for the most part quite uniform. They contain one but rarely two small round rather dense nuclei in which the chromatin material appears as coarse granules. The nucleus is usually centrally placed and in most instances occupies a large portion of the cell. The cytoplasm is moderate in amount and often appears as a small rim about the nucleus. It is finely granular and quite



Fig 5 Photograph of tumor at operation Case 3



Fig 6 Photomicrograph of tumor. Note the fibroblastic character of the tissue and the intimate relationship between tumor cells and blood vessels. Case 3. (Hematoxylin and eosin, $\times 105$).

eosinophilic. Mitotic figures are present but not numerous. The tumor has an abundance of fine, collagenous stroma which supports numerous, fair size blood vessels. Specific stains fail to reveal fibroglia.

Degeneration is quite extensive and gives the tissue a loosely woven appearance. Definite whorl formation in the tumor is not present and streaming, although present, appears most marked where degeneration is present. In some areas the cells are in close contact to form sheets while in other places, streaming and parallelism predominates (Fig. 3). Extensive degeneration causes the tissue to appear under low magnification as focal cell collections separated by bands of fine collagenous connective tissue. The tumor is regarded as a fibroblastoma.

CASE 3. The patient, a $3\frac{1}{2}$ year old white girl, entered the hospital in February, 1935 because of difficulty in the use of the right arm and leg. About 7 months prior to admission she had been knocked over by a dog and had fallen forcibly, but there was no history that she had struck her head. About that time the parents noticed a tremor in the right hand while the child was eating. Upon medical advice, she was put to bed for 1 week but upon getting up uncertain gait and marked difficulty in walking up and down stairs had been noticed. The child had become quite irritable and it was observed that the left hand was used much more than the right. There had been an increase of about 1 centimeter in the circumference of the head in the preceding 7 months. At no time had there been headaches or vomiting and speech had been normal.

Examination at the time of admission showed a bright child with a large head and an uncertain gait. The pupils were somewhat dilated but were equal and regular and responded normally to both light and distance. There was no nystagmus and the extra-ocular muscles were normal. Macewen's sign was positive. There was questionable slight weakness of the right lower portion of the face and the right hand, and definite ataxia of the right hand and leg. Deep and superficial reflexes were all active and equal but the Babinski response was present on the right. Both optic discs showed definite choking, and pressure over the left temple caused some pain. Perimetry was not carried out. The clinical diagnosis made was left frontal lobe tumor.

On the day following admission during the process of ventriculography a cyst was encountered through a drill opening in the left parietal region and about 30 cubic

centimeters of thick yellow fluid was removed at a depth of about 4 to 5 centimeters. Following this procedure, air was introduced but from the subsequent films it was impossible to state whether the injected air outlined a cyst or an obstructed posterior horn of the left lateral ventricle. Consequently, 90 cubic centimeters of fluid from the right lateral ventricle was replaced with air and roentgenograms were made. These revealed a dilated right ventricle which was dislocated to the right and an obstruction at about the midpoint of the body of the left ventricle (Fig. 4). The diagnosis of left parieto-occipital cystic glioma was made and immediate operation performed.

Through a left parietal craniotomy opening, the brain was explored. The cerebral surface appeared normal with the exception of two gyri in the inferior portion of the parietal lobe. These were pale yellow, and soft, and, upon exploration with a biopsy cannula, increased resistance was encountered at a depth of about 5 centimeters. Several small fragments of tissue were removed with the cannula but because of the location and depth of the growth it was considered unwise to attempt its removal. The tissue removed proved to be normal brain tissue without evidence of inflammation or neoplasm.

The postoperative course was uneventful and the patient was discharged on the sixteenth day after operation. There was no measurable choking of the optic discs and the degree of ataxia was decidedly less than at the time of admission. Roentgentherapy was instituted and the child continued to make good progress until about 2 months after discharge, at which time she suffered from an illness in which vomiting was a prominent feature. Following this episode the use of the right side was definitely impaired. Symptoms of pressure developed gradually until, in November, 1935, 10 months after the first admission, the patient was re-admitted for aspiration of the cyst. About 100 cubic centimeters of syrupy, yellow fluid was removed with subsequent improvement in the child's condition. In January, 1936, it was necessary again to aspirate fluid. At this time the child had complained twice of headache, and spontaneous vomiting had been present. One hundred cubic centimeters of fluid was removed but with much less improvement than was formerly obtained. The subsequent course was down-hill and in March, 1936, it became apparent that radical operation was the only measure which could

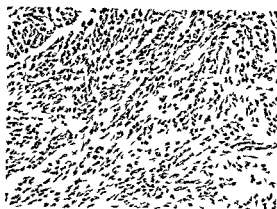


FIG. 3. Photomicrograph of tumor. Note evident fibroblastic character of the cells. Case 2 (Hematoxylin and eosin $\times 187$)



FIG. 4. Pre-operative ventriculogram. There is marked dilatation of the right ventricle. In the left ventricle there is an obstruction at about the midpoint of the body so that only the anterior portion and the occipital horn is visualized. Case 3

sternum. About 6 weeks before admission the patient had been hospitalized elsewhere for observation and at that time ataxia with staggering to the right had been noted. For 5 days prior to the first hospitalization there had been marked drowsiness and regurgitation of food through the nose had prevented him from obtaining much nourishment.

Neurological examination gave definite evidence of an expanding intracranial growth, although localization was uncertain. There were bilateral choked discs with edema of one diopter on the right and two diopters on the left. The left pupil was fixed to light and although a definite nystagmus was absent, horizontal nystagmoid jerks were present when the patient fixed the eyes to the left. A partial lower facial paralysis was present on the right and there was generalized muscular weakness most marked in the right arm and leg. Sensation was normal throughout. Ataxia was present and the Romberg test was positive, the tendency being to fall to the right. Moderate bilateral adiadochocinesia was present also. The abdominal reflexes were absent and the gag reflex was impaired. The posture causing the patient the least discomfort was with the head bent forward and the chin resting on the chest. Perimetry could not be carried out. Roentgenograms of the skull gave evidence of long standing increased pressure. There was atrophy of the dorsum sellae and clinoid processes with erosion of the floor of the sella turcica.

Ventriculograms taken on the third hospital day showed the anterior part only in the posterior portion of the right ventricle and this was displaced to the right. The ventriculographic diagnosis was tumor of the left frontal lobe.

Left frontal craniotomy was performed following ventriculography. The exposed brain was tense but otherwise normal in appearance. Incision into the brain exposed the outer surface of a firm, encapsulated tumor confined within the anterior horn of the left lateral ventricle. After considerable difficulty the tumor was removed in two large pieces. Free bleeding occurred from the tumor bed, the blood coming from the vessels of the choroid plexus about the foramen of Monro.

Following a stormy postoperative course in which infection complicated recovery, the patient was discharged on the forty-fifth hospital day. He was re-admitted a month later complaining of drowsiness, weakness and projectile vomiting. Neurologic examination was essentially negative but in view of a previous infection and the presence of a high spinal fluid cell count, exploration for a cerebral

abscess was carried out. No lesion was discovered and subsequent ventriculographic studies revealed nothing abnormal aside from the presence of a moderate dilatation of the ventricles. The patient was discharged on the seventh hospital day with considerable improvement in his condition. He died, however, 1 month later. No autopsy was granted.

Pathological description. The weight of the two large tumor masses was 100 grams. The larger measured 7 by 5.5 by 5.5 centimeters and with the exception of one surface which was cut across in removal, the tumor was covered by a smooth, thin, glistening capsule in which numerous veins were visible. The surface was irregular with numerous large bosses. Sections through the tumor mass revealed a uniformly white, somewhat granular surface with numerous areas of recent hemorrhage. No cysts were present and gross calcification was not observed. The smaller mass weighed 45 grams and measured 4.5 by 4 by 3.5 centimeters. The texture was similar to that of the larger mass but due to the presence of more diffuse hemorrhage its color was grayish red.

Tissue taken from various portions of the tumor was stained by the methods listed previously. Here again the staining quality of the tissue interfered with the microscopic study of the growth.

Microscopically there is a thin capsule composed of loosely woven connective tissue in which numerous large and small vessels are present. The cells are arranged in sheets and although the overall impression is one of marked streaming and parallelism, close examination reveals the fact that this picture is due to the peculiar type of stroma present. The individual tumor cells are small, round or elongated and for the most part quite uniform. They contain one but rarely two small round rather dense nuclei in which the chromatin material appears as coarse granules. The nucleus is usually centrally placed and in most instances occupies a large portion of the cell. The cytoplasm is moderate in amount and often appears as a small rim about the nucleus. It is finely granular and quite

While in many instances the symptoms are less than 1 year in duration there are wide variations. The successful removal of an intraventricular tumor from a patient in whom symptoms had been present for 22 years has been reported (10). It must be remembered that, in tumors in this location, the duration of symptoms is no index of the malignancy of the growth since, by reason of their location, they may block circulation of the cerebrospinal fluid and produce fulminating signs of increased intracranial pressure, despite the fact that they may be encapsulated and perfectly benign.

PATHOLOGICAL CONSIDERATION

Tumors arising from the choroid villi have been described and usually referred to as psammomas (3, 11) or meningiomas (8). Although the microscopic structure of these tumors is variable many of them cannot be distinguished from the common variety of meningioma. The tumors described here differ from the common variety of meningioma and, for reasons to be discussed, have been called fibroblastomas.

As has been pointed out elsewhere (2) cerebral neoplasms composed almost exclusively of fibroblastic elements are extremely uncommon. Their origin has not yet been definitely established, although Alpers has stated that these tumors may arise from the pia, the vascular adventitia, or the perithelium of the blood vessels. Inasmuch as the embryological derivation of the leptomeninges is still the subject of considerable debate, the term fibroblastoma eventually may prove to be incorrect.

There are several reasons for believing that the tumors described here arose from the mesodermal elements of the choroid plexus. Collagen fibrils, fibroglia fibrils, and elastic fibers are known to be the products of cells potentially fibroblastic. The first tumor described is densely fibrous and quite cellular and contains considerable intercellular collagenous material. In the third tumor, in addition to an abundant collagenous stroma and numerous fibroblasts, there are scattered areas in which fibroglia fibrils are present. While the fibroblastic character of the second tumor cannot be established definitely it appears that all three tumors are fibroblastomas. None of the tumors

contained a definite reticulum. The three tumors described here probably arose from the fibrous elements of the choroid plexus, either from the numerous fibroblasts found normally in the choroidal villi or from cells potentially fibroblastic.

SUMMARY

1. Three cases of primary fibroblastoma of the choroid plexus of the lateral ventricle have been described. All 3 tumors were removed at operation.
2. In none of the 3 cases was the intraventricular location of the tumor suspected from the clinical findings and in all 3 cases the exact localization was made at operation.
3. The tumors are of mesodermal origin and probably arose from the fibrous elements of the choroid plexus or tela choroidea.

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possibly save the child. At this time there was a high degree of papilledema, marked ataxia and separation of the cranial sutures.

Through a craniotomy opening, corresponding to that of the previous operation, the left parietal region of the brain was again exposed. An incision through the cortex disclosed a collection of 6 or 8 cysts, all of which were located in a greatly dilated posterior horn of the ventricle. Evacuation of these brought to view a large firm smooth encapsulated tumor lying anteriorly (fig. 5). With the electrocautery, a loop the tumor was removed piecemeal until there remained only a small portion of its anterior wall which was found to be attached to the choroid plexus at a point opposite a greatly dilated foramen of Monro. The vessels of the choroid plexus were greatly dilated and represented the only point of attachment of the growth. After coagulation of these it was possible to remove the last fragment of tumor tissue. An enormous cavity resulted; the walls of which consisted of the ependymal lining of a greatly dilated lateral ventricle. The cavity was filled with saline and the wound was closed in the usual manner.

The subsequent course was uneventful and the patient left the hospital on the eleventh day after operation. At the time of discharge there was some residual paresis and ataxia of the right side but not demonstrable aphasia. Nine months after operation the patient was able to run and walk alone. She was able to use the right arm and leg and her condition had continued to improve steadily. However there was still a definite right hemiparesis.

Pathological description. The total amount of tumor tissue removed weighed 217 grams. The largest piece measured 4.5 by 4.5 by 3 centimeters and was covered on its outer surface by a thick, yellowish gray to grayish white capsule. At one point a fragment of choroid plexus was attached to the surface. The tissue was quite firm and upon section presented a homogeneous yellowish gray somewhat granular surface.

Sections taken from various parts of the tumor were stained by the methods already enumerated. The tumor is covered with a moderately thick capsule consisting of fairly cellular collagenous connective tissue in which numerous large and medium sized blood vessels are present. The tissue is composed of sheets of cells of the connective tissue type with fairly marked streaming and somewhat less marked whorl formation. Degeneration is extensive throughout the tissue.

The parenchymal cells are fibroblasts with elongated compact and highly chromophilic nuclei and a fair amount of pink staining cytoplasm which is bipolar in distribution (fig. 6). Intercellular material is abundant and forms a heavy collagenous carpet. Mitotic figures are not commonly found. Vessel spaces are quite numerous and about these there is some tendency for whorl formation with an intimate relationship existing between the walls of the vessel and the surrounding tumor tissue.

Although not very abundant there are isolated areas in which fibroblast fibers can be seen. Scattered here and there throughout the tissue are small focal collections of hyperplastic epithelium derived from the choroid plexus. These have round vacuolated centrally placed nuclei and a small amount of very lightly staining cytoplasm with almost no definition of cell boundaries. No reticulum could be demonstrated in the tumor tissue either with the Wilder or Weidman method although the latter demonstrated beautifully the abundant intercellular collagenous stroma. Sections taken at a point corresponding to the choroid plexus seen on the gross specimen reveal the presence of numerous villi containing large and small vessels with thin poorly formed walls.

The tumor is regarded as a typical fibroblastoma.

CLINICAL CONSIDERATIONS

Although the incidence of tumors of the lateral ventricle is relatively low they arise often enough in neurosurgical practice to make their clinical consideration of value. There is no clinical picture which will localize an intraventricular growth although there are certain neurological features which may at times direct attention to the possibility of a lesion in this location. This is particularly true when localizing signs are absent in the presence of an obviously expanding intracranial lesion.

Periodic headaches or intermittent attacks of increased intracranial pressure have both been cited as the most suggestive evidence of a growth within the lateral ventricle (5). This periodicity is due to the ball valve action of the tumor and can occur in other parts of the ventricular system, namely in the third ventricle (6). When the large size of the tumor prevents it from moving freely or when local adhesions fix the tumor in one position this phenomenon may be absent as it was in the 3 cases presented here. Obvious signs of increased intracranial pressure may be late in developing in patients of the younger age group since here cranial suture separation may serve to decompress the brain until the bulk of the tumor plus the concomitant cerebral edema overcomes this compensation. Of the host of signs and symptoms described hemianesthesia and hemiplegia have been pointed out as the most important localizing evidence. This is interesting in view of the fact that in none of the 3 cases described here was there any evidence of sensory impairment. Many of the signs are misleading and in one instance at least the presence of staggering gait, ataxia and positive Romberg's sign has led to cerebellar exploration (7).

Intraventricular tumors appear to occur most frequently during the first three decades of life. Dandy (5) found that in about 67 per cent of the cases of tumor of the lateral ventricle, the patients were less than 31 years of age at the time of operation or necropsy and that nearly 50 per cent of these tumors occurred before the age of 21 years. Van Wagenen has reported the successful removal of a papilloma of the choroid plexus from the lateral ventricle of an infant 3 months old and Graves and Fliess report the occurrence of a similar tumor, found at autopsy, in the left lateral ventricle of an infant 9 months old. Tchernyschew and his associates have reported a psammoma which was located in the right lateral ventricle of a boy 10 years old and Christophe has reported a similar tumor which was found in a boy 13½ years old.

by (1) inspection and palpation of the tumor; (2) palpation of the lymph nodes in the neck; (3) biopsy of the tumor. The findings of each of these examinations should be known before treatment is decided upon. Biopsy tissue can be taken from the ulcerated surface of the tumor with a punch; this step should be a simple one and should not cause pain or danger to the patient. The report of the pathological examination must go further than merely state the presence or non-presence of cancer. It should, if an epidermoid carcinoma, give information as to the index of malignancy according to Broders or some similar classification.

An attempt at cure should be made in cases in which the largest lymph node is 1 centimeter or less, and in which the tumor is not over 2 centimeters in diameter, if of pathological grades 2 or 3 and also if the tumor is wider than 2 centimeters, but not over 4 centimeters provided the lesion is of papillary type, does not infiltrate, and is of pathological grade 1.

THE PREPARATION OF THE PATIENT FOR CURATIVE TREATMENT

Good hygiene of the mouth must be achieved before starting any course of curative treatment. In more cases this will entail extensive extractions than it will entail mere cleaning and temporary filling of teeth. This takes time, but it is believed to be so important that up to a week or 10 days for the extractions and partial healing of the sockets may well be spent in this effort before operation or radiation. Many serious post-treatment infections are thereby avoided and no appreciable increase in the size of the tumors have been noted during this time.

THE CURATIVE TREATMENT OF THE LOCAL LESION

The results of treatment by modern methods are very close to each other. A clean surgical excision by endothermy probably gives the least painful convalescence. We tend to favor this method especially if there is associated leucoplacia, as the latter does not respond well to radiation. A proper surgical endothermy or surgical excision operation should excise or devitalize the normal tissue to a distance of at least $\frac{1}{2}$ centimeter in all directions beyond the edge of the gross cancer, and if possible, 1 centimeter distance is better. Endothermy combined with surgical excision is absolutely the method of choice if there is invasion of the jaw. A wide resection of the jaw will be followed by cure in many such cases. In an increasing number of the curable

TABLE I.—CLINICAL VERSUS PATHOLOGICAL EXAMINATION OF NODES OF NECK

Pre-operative diagnosis	Per cent correct	Pre-operative size cm	Per cent involved
Positive	54	1.0 or less	45
Negative	65	1.1 or over	100

cases, however, the treatment starts with a series of 2000 to 3000 r units of short wave x-ray, given through the skin or 1500 units intra-orally if the tumor is so located that this is feasible. When this treatment is started, no change is ever made to surgery later. Three weeks after the first treatment the situation is reconsidered and further treatment given by either more x-ray or by the implantation of radium needles. A third series of treatments is given by x-ray at the end of a second 3 weeks when the dose is pushed to the limit of tolerance of the skin, the underlying tissues, and the patient. This is not necessarily the only way to give x-ray. Berven, of Stockholm, favors daily doses for 1 month, totalling 5000–6000 r units. If, after this treatment, the tumor has not regressed or, if after regression it recurs, no further effort is made to cure. After several months a few hundred, but only a few hundred, r units may be tolerated for palliative purposes.

THE CURATIVE TREATMENT OF INVOLVED GLANDS IN THE NECK

It is often impossible to tell by clinical examination whether glands palpated in the neck are actually involved by cancer or not. There are two reasons for this. First, very small, impalpable glands may have a small cluster of cancer cells in them. Second, due to the infection of the teeth or the secondary infection of the ulcerated primary cancer the glands may be considerably enlarged due to their reaction to the infection, and yet contain no cancer cells. It goes without saying that really large glands practically always do contain metastases. Table I will show the difficulty of telling by any criteria on physical examination whether nodes are involved or not.

The data on comparison of the examiner's opinion as to the presence of cancer in the neck are from the paper by Simmons published in 1930, and the data on the described size, from reference Lund (4).

It is generally recognized that any feasible dosage of x-ray or external radium will very rarely cure metastatic epidermoid carcinoma in glands, and that the cure of such glands by implanted radium is extremely unlikely due to the

EPIDERMOID CARCINOMA OF THE BUCCAL MUCOSA

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BUCCAL cancer is typically an epidermoid cancer and typically very malignant. The results of treatment by any means, surgery, radium, or x ray, cannot by any criteria be considered to be at all satisfactory except in a very few, very small cancers and a few others that are of a relatively low grade of malignancy. (4) Most of the few cases that are amenable to cure are curable by any of the afore mentioned forms of treatment properly given. This situation does not prevail with respect to any other form of cancer except that arising in the skin or on the lips. Of course, in the latter two locations the cancers are much more frequently curable. This paper will discuss epidermoid cancer only, of the following locations: tongue, floor of mouth, upper and lower gingival mucosa, both palates and inside of cheeks. Notice that cancers of the tonsil and lips are not included and that the very rare adenocarcinomas and the so called lympho-epithelioma are not included. The characteristics of these other types and locations of cancer are so different that a wholly separate paper would be needed to discuss them in any worth while manner.

CAUSE AND PREVENTION OF BUCCAL CANCER

Normally the mucous membrane of the mouth is comparatively resistant to the development of cancer as shown by the fact that women who very largely do not chew tobacco or smoke pipes and whose mouths average much cleaner in other ways than men do, have buccal cancer but one eighth as frequently as men. (2) This statement holds approximately true for Europe, America, and many other parts of the world but not for countries where betel nut chewing is commonly practiced by both sexes. The etiological factors well recognized to be causative of mouth cancer are first, overuse of the stronger forms of tobacco such as, in order, chewing either plain tobacco or snuff, pipe smoking and cigar smoking; second, dirty broken infected teeth; third important for some unknown reason in tongue cases only tertiary syphilis. In most cases of buccal cancer at least two of these factors are present and have been operating over a long period of time. It is

unfortunate that the irritative factor that leads to mouth cancer does irreversible damage to the tissues long before any visible effect takes place. This of course is similar to the effect of x ray or the various tar chemicals, whose effects may be demonstrated only following a long latent period but if sufficient dosage has been given will be shown eventually even if further administration of the agent be stopped.

This is mentioned because in this disease even more than in most diseases the prevention of it is better than the cure and it can be largely prevented. How far should one go in recommending preventive measures? Should we advise the confirmed pipe smoker to give up his pipe? I am afraid such advice would go unheeded. Notice that two or more of the causative factors are nearly always needed to cause this kind of cancer. Therefore, it would be fairly safe for the young man about to begin to enjoy adult pleasures to follow these rules: (1) avoid syphilis, or if an accident has happened be treated efficiently, (2) either do not use tobacco or keep the teeth with the help of a dentist, in perfect order at all times.

THE SELECTION OF PATIENTS FOR CURATIVE TREATMENT

As with other kinds of cancer the patients must be sharply divided into two classes: (1) those in whom an attempt will be made to cure; (2) those in whom palliation only will be attempted. Ill advised attempts to cure will often result in excessive suffering and will even prevent effective palliation. The converse use of palliative measures when curative methods are indicated leads to an even more tragic result. Except for the occasional patient who has serious complicating disease or is very feeble from old age no wide search has to be made before deciding on the curability of the cancer. No x ray pictures are indicated to hunt for metastases as the disease practically never shows metastases below the clavicle except in such a late stage that local cure is impossible. When, however, a cancer is adherent to the upper or lower jaw x ray examination of this one bone is indicated to demonstrate the amount of direct extension.

Except as indicated herein the decision as to curability of the individual case is determined

From the Cancer Commission of Harvard University.
Read before the section meeting of the American College of Surgeons, Halifax, Nova Scotia, May 21, 1937.

by (1) inspection and palpation of the tumor; (2) palpation of the lymph nodes in the neck; (3) biopsy of the tumor. The findings of each of these examinations should be known before treatment is decided upon. Biopsy tissue can be taken from the ulcerated surface of the tumor with a punch, this step should be a simple one and should not cause pain or danger to the patient. The report of the pathological examination must go further than merely state the presence or non-presence of cancer. It should, if an epidermoid carcinoma, give information as to the index of malignancy according to Broders or some similar classification.

An attempt at cure should be made in cases in which the largest lymph node is 1 centimeter or less, and in which the tumor is not over 2 centimeters in diameter, if of pathological grades 2 or 3 and also if the tumor is wider than 2 centimeters, but not over 4 centimeters provided the lesion is of papillary type, does not infiltrate, and is of pathological grade 1.

THE PREPARATION OF THE PATIENT FOR CURATIVE TREATMENT

Good hygiene of the mouth must be achieved before starting any course of curative treatment. In more cases this will entail extensive extractions than it will entail mere cleaning and temporary filling of teeth. This takes time, but it is believed to be so important that up to a week or 10 days for the extractions and partial healing of the sockets may well be spent in this effort before operation or radiation. Many serious post-treatment infections are thereby avoided and no appreciable increase in the size of the tumors have been noted during this time.

THE CURATIVE TREATMENT OF THE LOCAL LESION

The results of treatment by modern methods are very close to each other. A clean surgical excision by endothermy probably gives the least painful convalescence. We tend to favor this method especially if there is associated leucoplacia, as the latter does not respond well to radiation. A proper surgical endothermy or surgical excision operation should excise or devitalize the normal tissue to a distance of at least $\frac{1}{2}$ centimeter in all directions beyond the edge of the gross cancer, and if possible, 1 centimeter distance is better. Endothermy combined with surgical excision is absolutely the method of choice if there is invasion of the jaw. A wide resection of the jaw will be followed by cure in many such cases. In an increasing number of the curable

TABLE I.—CLINICAL VERSUS PATHOLOGICAL EXAMINATION OF NODES OF NECK

Pre-operative diagnosis	Per cent correct	Pre-operative size cm	Per cent involved
Positive	54	1.0 or less	45
Negative	65	1.1 or over	100

cases, however, the treatment starts with a series of 2000 to 3000 r units of short wave x-ray, given through the skin or 1500 units intra-orally if the tumor is so located that this is feasible. When this treatment is started, no change is ever made to surgery later. Three weeks after the first treatment the situation is reconsidered and further treatment given by either more x-ray or by the implantation of radium needles. A third series of treatments is given by x-ray at the end of a second 3 weeks when the dose is pushed to the limit of tolerance of the skin, the underlying tissues, and the patient. This is not necessarily the only way to give x-ray. Berven, of Stockholm, favors daily doses for 1 month, totalling 5000-6000 r units. If, after this treatment, the tumor has not regressed or, if after regression it recurs, no further effort is made to cure. After several months a few hundred, but only a few hundred, r units may be tolerated for palliative purposes.

THE CURATIVE TREATMENT OF INVOLVED GLANDS IN THE NECK

It is often impossible to tell by clinical examination whether glands palpated in the neck are actually involved by cancer or not. There are two reasons for this. First, very small, impalpable glands may have a small cluster of cancer cells in them. Second, due to the infection of the teeth or the secondary infection of the ulcerated primary cancer the glands may be considerably enlarged due to their reaction to the infection, and yet contain no cancer cells. It goes without saying that really large glands practically always do contain metastases. Table I will show the difficulty of telling by any criteria on physical examination whether nodes are involved or not.

The data on comparison of the examiner's opinion as to the presence of cancer in the neck are from the paper by Simmons published in 1930, and the data on the described size, from reference Lund (4).

It is generally recognized that any feasible dosage of x-ray or external radium will very rarely cure metastatic epidermoid carcinoma in glands, and that the cure of such glands by implanted radium is extremely unlikely due to the

TABLE II—CURE OF CASES BY RADICAL OPERATION

	Cases	5 year cures	Per cent
Glands positive	10	3	30
Glands negative	17	5	29

Quoted from previous art. 1c (4)

TABLE III—RELATION OF GRADE AND SIZE TO GLANDULAR METASTASIS

Size of les on cm	Grade I		Grade II		Grade III		Total	
	Cases	No glands per cent	Cases	No glands per cent	Cases	No glands per cent	Cases	No glands per cent
0-1.0	3	100	2	50	3	33	8	63
1.1-2.0	9	67	17	35	12	17	38	57
2.1	17	71	23	13	14	0	54	18
Total	29	72	42	24	29	11	100	34

difficulty of securing curative dosage in all the glands that may be involved. For these reasons one must state positively that if a patient has cancer in the glands his only important chance of cure is by surgery. What is this chance? In a previous paper (4), the results of radical operations on 33 such patients were reported. Radical operation is defined as an adequate local excision by knife, cautery, or endothermy, plus a neck dissection which includes the removal on one side of the submaxillary gland, submental gland, the greater portion of the sternomastoid muscle and of the internal jugular vein, together with all the gland bearing tissue from the clavicle to the jaw. The results following this operation are given in Table II. This table includes only cases in which the pre operative description of the glands was given as small or not over 1 centimeter in diameter. In 7 other cases with larger glands none resulted in a 5 year cure.

Table II shows that it is possible to cure by surgery patients with buccal cancer who have small cervical metastases. Therefore if the patient is otherwise curable and the glands are thought to be involved a radical neck dissection should be done, whether the primary lesion is irradiated or excised. This dissection should be done before, rather than after, radiation treatment as in most instances of radiation to buccal cancer the tissues of the upper neck will be so seriously damaged by the radiation that fatal infection is not unlikely to occur after operative procedure.

TABLE IV—EPIDERMOID CARCINOMA OF THE BUCCAL MUCOSA

Location	Cases	No glands—per cent
Palate	3	100
Upper jaw	8	50
Floor	11	45
Cheek	16	38
Tongue	46	26
Lower jaw	18	23
Total	100	34

TABLE V—510 PRIMARY CASES, SMALL GLANDS

Size—cm	Cases	Cures	Per cent
0-1.0	30	13	43
1.1-2.0	103	19	18
2.1+	386	22	6
Total	510	54	11

If I should be asked whether we always do such neck dissections in favorable cases (as described herein) the answer would have to be no. What defense is there for not doing them in view of the data presented as the impossibility of telling from the examination of the neck as to the presence or absence of glands? Still other criteria have been used. These criteria concern the location, character, size, and pathological appearance of the primary tumor itself.

THE DETERMINATION OF CASES THAT WILL PROBABLY NOT HAVE INVOLVED NODES

Table III is constructed on the basis as to whether positive involvement of the nodes was found either at operation or developed so that it was obvious at any subsequent time. The operations were by no means always radical ones. The pathological grades were determined by Dr. C. C. Simmons. It is seen that the chance of gland metastasis is comparatively small in low grade tumors and also is small in very small tumors. Therefore, we believe that it is safe not to do a primary neck dissection if this combination is found.

As a matter of fact, unless there is evidence from the glands themselves we do not do such dissections if the tumor is either small or low grade. The 'large' low grade tumors that are cured are nearly always those papillary ones that cannot be distinguished clinically from cases of papillary leucoplakia except on microscopic examination.

In other types of cancer the duration of the history of cancer has often been used as a criterion for doing non-radical surgery. In the mouth our histories are particularly unreliable as there is difficulty in knowing when actual cancer began in the presence of a patch of leucoplacia. It may be stated that duration as found expressed on our histories does not help us make this decision.

However, the location in the mouth is important. From the same paper quoted in Table III is found the data in Table IV.

It may be seen from Table IV that the danger of gland metastasis is distinctly less when the cancer arises elsewhere than on the tongue and lower jaw. Therefore, the location of the tumor must also be considered when a decision is made for or against active treatment of the lymph nodes.

RESULTS OF TREATMENT

In my previous paper (4), tables of results are given. They show as stated before that the form of treatment given (surgery or radium) is not so important as the choice of cases for treatment or the correctness of application of the particular treatment. In the great bulk of cases the results are discouraging. In cases with small or no enlargement of the lymph nodes the "cures" amount to only 11 per cent as seen in Table V. However, this table is not a fair statement of the results of curative treatment as at least half of the cases were incurable because of local exten-

sion of the disease and were given x-ray treatment for palliative purposes only.

Table V shows 3 things: first, the very small number of cases coming in when the lesion is small; second, the really good results obtained in these cases, and third, the nearly hopeless situation that is found in the more advanced cases.

SUMMARY AND CONCLUSIONS

1. Epidermoid carcinoma of the buccal mucosa in most cases is difficult to cure.
2. Very small, and pathologically low grade tumors are very susceptible to cure by proper application of any recognized method.
3. Therefore, there is a tremendously important field in relation to this kind of cancer: the education of the public and of the doctor in order to bring about better results.
4. The choice of treatment has been discussed.

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EDITORIALS

SURGERY Gynecology and Obstetrics

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APRIL 1938

THE CHOICE OF SUTURES IN THE SURGERY OF THE LARGE INTESTINE

IN the current discussion as to whether resection of the large intestine should be done in one stage, or in several by some adaptation of the principle of Mikulicz the significance of the method of suture employed seems not to be fully appreciated. This is of great importance because of certain conditions associated with the large intestine which do not obtain to the same degree in the small intestine.

Such are the infectiousness of its contents, the vulnerability of its blood supply, and the thinness of its walls. Minor soiling of the peritoneum by the contents of the stomach, duodenum, jejunum, or ileum, while to be avoided if possible, does not carry the grave danger of a spreading peritonitis as does a contamination from within the large bowel. Similarly, relatively gross interruption of the blood supply in the former where the anastomotic circulation is so profuse, has not the

danger of causing necrosis that it has in the latter where the interruption of a single terminal vessel may at times lead to a localized ischemia at the suture line. Then too, the walls of the colon, particularly in the sacculi are of a thinness which allows a smaller margin of safety as regards both the placing of the suture and its holding power.

It is apparent then that, although the large bowel seems to be a grosser structure than the small, the surgical manipulation of it requires a more rigorous technique. This may be on the one hand the abandonment of a suture method within the abdomen and the carrying out of a resection and anastomosis extra peritoneally as is the case with the Mikulicz principle, or, on the other hand, the refinement of the method of suture. Should the latter produce as good results as the former, then there would be no question in any one's mind as to its desirability.

That it can do so in the hands of those accustomed to the employment of the fine silk technique seems probable, while the attempt to do so with the relatively gross manipulations accompanying the use of catgut sutures seems improbable. The latter even in the larger sizes and with attached needles tends to tear as the running suture customarily employed is drawn taut, and the fault is intensified in the large sizes and with the threaded needle. In addition any type of aseptic or relatively aseptic form of anastomosis is dependent upon the accurate placement of multiple interrupted sutures and is well nigh impossible to carry out in the large intestine with catgut. On the other hand fine twisted silk mounted on an equally fine needle and used in interrupted stitches can be employed with great accuracy and with a minimum of damage to the wall of

the large intestine and its circulation. When perforations into the lumen occur, there is to a far lesser degree danger of serious leakage, while soiling of the peritoneal cavity during resection and anastomosis can be avoided by the use of an aseptic or relatively aseptic method of anastomosis which this refined technique permits.

From this consideration of the relative value of the resection and anastomosis according to the Mikulicz principle and that of resection and primary suture of the large intestine, it would seem that to those familiar with and experienced in the fine silk technique, the latter will be preferable, but that to those who for any reason persist in using catgut in the surgery of the large intestine, the Mikulicz procedure is the safer one.

SAMUEL C. HARVEY.

TREATMENT OF COMPOUND FRACTURES

THIS is not an extended treatise on the treatment of compound fractures but an attempt to emphasize three important points

1. *Early attack.* Following the accident, the period in which it is possible, by débridement and thorough irrigation, to prevent infection is a limited one. Probably after 2 hours and surely after 4, the best we can hope for by such treatment is to limit the severity and the extent of the infection. Therefore, the operative attack should not be delayed, except for extreme shock.

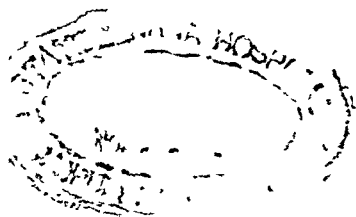
2. *Early reduction.* After infection has developed it may be unwise to attempt a reduc-

tion of displacement of the fragments lest the infection be carried into areas as yet uninvaded. After the infection has subsided, new bone formation and the condition of the adjacent soft parts will usually prevent proper adjustment. The time to obtain satisfactory alignment is when the débridement is carried out. It is apt to be then or never. Surgeons are apt to wait for a better time to reduce the displacement. There is no better time than right away.

3. *Immobilization.* During the process of repair, it is of the greatest importance that the zone of infection be limited as much as possible. Any motion of the bone ends tends to tear the young granulation tissue and to break down the barriers of resistance. Traction and suspension alone do not provide sufficient immobilization. Circular plaster, even if carried well beyond the adjacent joints, is not always sufficient. This is especially true when a large window has to be cut in the plaster to allow treatment of the wound. Molded plaster gutters in connection with traction and suspension should be used more often than they are.

The use of internal fixation by screws and perhaps plates is often definitely indicated. In many comminuted cases it is the only way by which the proper length can be maintained. Their use in compound fractures frequently will limit the area of infection and hasten repair. They should be regarded as a temporary means of maintaining immobilization and should be applied in such a manner as to permit their removal with as little additional trauma as possible.

WILLIAM DARRACH.



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The parts dealing with malignant tumors of the pharynx and larynx by Lionel Colledge, tongue, mouth, and lips by Stanford Cade, and the esophagus and diaphragm by Laurence O'Shaughnessy are deserving of special mention. It was a delight to read them.

Parts are devoted to the medical aspect of surgery, hernia, plastic surgery, obstetric surgery, orthopedics, eye, ear, nose, endoscopic methods, tonsils and adenoids and retropharyngeal abscess, mandible, teeth, venereal disease, physical medicine, deep X-ray therapy, some aspects of general surgery including shock, blood transfusion by the continuous drip method, gangrene, burns and the like, and some neurological and psychiatric aspects of surgery.

Because of lack of space it is impossible to give an adequate impression of the entire work. It is replete with vital information and a ready assistant to the student of surgery.

After having carefully surveyed the three volumes of *Post-graduate Surgery* an impression as to the merits of the system as a whole is volunteered. It consists of 5500 pages of material prepared by 59 authors, each a recognized master of his specialty. Much of the fundamental material depicting basic principles of surgery has been purposely omitted because the editor assumes that the post-graduate student should be in possession of this information and if not it can be procured in practically any textbook of surgery. Therefore the 5500 pages are devoted to what may be termed live clinical surgery. The presentation is excellent and the illustrations are numerous and beautifully done. Many subjects are treated exhaustively. The final opinion is that this work is probably the most complete and modern of any of its kind to be found today. The reviewer will cherish this system and use it frequently. In trying to offer a criticism, one fault may be found: a volume of 2000 pages is too large and heavy for convenient reading. JOHN A. WOLFER

THE first part of the book *The Physiology of the Kidney*¹ by Homer W. Smith contains a good discussion of the physiological anatomy of the kidney and a review of the theories of renal function with some added recent concepts of the author. Smith has presented supportive experimental evidence for the theory of tubular excretion as seen in the aglomerular fish and embryonic preparations of lower animals.

The rôle of the kidney in mineral metabolism, acid-base balance, and water excretion is well handled from a practical standpoint, and helps to elucidate some of the problems and findings of advanced renal disease. The action of diuretics on the kidney is summarized.

Much of the book is devoted to the "concept of renal clearance." The clearance of inulin, phenol red creatine, urea and glucose is discussed thoroughly, involving technical detail and a thorough knowl-

edge of biochemistry. The author believes that "independent absolute values of renal clearance are of little value" and, it is essential to observe the simultaneous clearance of two or more substances which we wish to compare.

It is unfortunate that the publishing of the book antedates the recent epoch making and generally accepted reports of the effect of renal ischemia. No mention of this work is made in the chapter devoted to renal blood flow.

The relationship of the kidney to the hypothalamus and adrenals is briefly discussed but the relationship of kidney and other organs such as heart, blood vessels, and liver are not elaborated upon.

As a whole the book is a scholarly presentation of the author's own experimental work on the physiology of the normal kidney of many laboratory animals. To this he has added an exhaustive review of the work of similar nature as initiated by Cushing and Richards.

It is a presentation written for those particularly interested in the subject of renal physiology, and not for the general practitioner. M. HERBERT BARBER

ONE need only scan the contents of this the fifth edition of Ormsby's *Practical Treatise on Diseases of the Skin*² to discover why it has been so extremely popular. In order to incorporate new material and yet keep the book reasonable in size a great deal of reconstruction has been done. Twenty new diseases are described, descriptions of 12 have been rewritten, and the entire work has been brought up to date. The bibliography, always an excellent one in all of the editions, has been improved by selecting articles on the various subjects which contain bibliography to the date of publication, thus reducing the literature references.

The revision of the histopathology and mycology by Dr. Finnerud is an excellent piece of work and under each disease, a complete description of the histopathological findings is given in a short, concise, yet comprehensive manner.

The volume always has been well illustrated with excellent black and white engravings and to this volume are added 44 new plates. The subject matter is sound and presented in a direct, concise manner, reflecting the extensive knowledge and long teaching experience of the author. This book is the most readable, the most understandable, and the most authentic of all the textbooks on dermatology printed in the English language. It would be impossible to find a better book on the subject of dermatology in which every disease of the skin is so accurately described and in which everything known to date about any given disease is so ably presented.

The book is printed on good paper in clear, readable type, interspersed with bold type for key words and headings.

¹THE PHYSIOLOGY OF THE KIDNEY. By Homer W. Smith, A.B., Sc.D., M.S. (Hon.) New York: Oxford University Press, 1937.

²A PRACTICAL TREATISE ON DISEASES OF THE SKIN, FOR THE USE OF STUDENTS AND PRACTITIONERS. By Oliver S. Ormsby, M.D. 5th rev. ed. Philadelphia: Lea & Febiger, 1937.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE mortality of acute bowel obstruction has always been high when contrasted with statistics of other types of acute abdomen. The death rate following operations to remedy the conditions is still inexcusable. Ignorance of the mechanism and effects of distention of the mechanism of death faulty diagnosis late operation and peritonitis resulting from the unskilled handling of distended bowel are factors which contribute to this high mortality. Therefore no treatise on the operative technique of bowel surgery is presented by Wangensteen in his recent book *The Therapeutic Problem in Bowel Obstructions*¹ but rather an experimental and clinical study of the effects of obstruction, methods of diagnosis and a description of conservative aids to recognized operative procedures.

This volume has three sections: (1) the therapeutic problem of acute bowel obstruction; an essay awarded the Gross prize in 1935; (2) general considerations of diagnosis and treatment in bowel obstructions; (3) the special obstructions. The following brief résumé contains facts which the reviewer believes worthy of special emphasis.

Obstruction produces distention and loss of fluid, the chief sources of distention are digestive fluids and swallowed air. Contrary to prevalent opinion high obstruction is less vicious than blocks in the lower bowel because vomiting prevents distention and attendant mechanical damage in the former type. Salt solution is a specific for the loss of electrolytes in high obstruction; it has no specific action in low obstruction. In obstructions of the colon the latter becomes a closed loop, because of the action of the ileocecal valve. Vomiting is infrequent and normal absorption occurs. The danger lies in possibilities of damage to the colonic wall from a sustained enteric pressure which may reach 24 centimeters of water. The cause of death in simple or non strangulated obstructions of the small bowel is not toxic absorption but loss of viability and subsequent permeability of the bowel wall leading to peritonitis.

Criteria for the diagnosis of obstruction are thoroughly discussed. Roentgenographic findings are of value in determining the approximate level and degree of obstruction as well as the efficacy of conservative decompression. The presence of peritoneal reaction is the important sign in differentiating simple from strangulating obstructions.

The therapy of bowel obstruction is summed up

as follows: (1) saline solution; (2) blood transfusions; (3) decompression with intubating duodenal tube; (4) operation. Transfusion of blood is particularly indicated in strangulating obstructions because of blood loss in the mesentery and bowel of the obstructed segment.

Conservative decompression, concerning which the author has made numerous experimental and clinical contributions to the literature is discussed at great length. A simple siphon device for maintaining suction is described. Criteria for determining the efficacy and limitations of suction are presented as well as are the indications for surgery. Some cases particularly those of partial obstruction will be relieved by suction. Aseptic enterostomy close to the obstruction level is the safest procedure in late cases with great distention. Surgical attack is still our most important therapeutic agent and should be resorted to promptly when conservative decompression fails.

In the opinion of the reviewer Wangensteen's work will long remain as the outstanding contribution to the treatment of acute obstruction. He has done a fascinating and intelligent piece of research. Could every doctor called upon to treat acute bowel obstruction be made to master the relatively few and simple concepts of the mechanism, diagnosis, and treatment of this catastrophe as herein presented the mortality would be reduced to a negligible percentage. J. R. BUCHSNER.

VOLUME 3 of *Post graduate Surgery*² the final volume has been released and is comparable in every way to the two previously issued. This large volume consisting of about 2000 pages has many points of interest. One part consisting of 164 pages is devoted to the surgery of the vascular system. Of this 56 pages are given over to a discussion of the surgery of the heart. This section is complete and contains all new material and is an excellent compilation of the data of the day pertaining to the subject. Probably the outstanding part of the volume is that devoted to the lymphatic system. As one surveys practically every text of surgery definite information pertaining to the lymphatic system is either very brief or vague. Here is to be found a very comprehensive yet concise dissertation upon the subject. The material is prepared by several authors: three chapters by Rodney Maling and an interesting chapter on Hodgkin's lymphogranuloma by Sir Humphrey Rolleston and an impression of status thymoplymphaticus by R. Sleigh Johnson.

¹ THE THERAPEUTIC PROBLEM IN BOWEL OBSTRUCTIONS, A PHYSIOLOGICAL AND CLINICAL CONSIDERATION. By Owen H. Wangensteen, M.D. Springfield, Ill.: C. C. Thomas, 1937.

² POST GRADUATE SURGERY. Edited by Rodney Maling, C. F. R. C.S. (Eng.). 1, 2, 3. New York: D. Appleton-Century Co. Inc., 1937.

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THE INFLUENCE OF THE SERUM PROTEIN ON THE MOTILITY OF THE SMALL INTESTINE

ROBERT P. BARDEN, M.D., WESLEY D. THOMPSON, M.D., I. S. RAVDIN, M.D., F.A.C.S.,
and IRVING L. FRANK, M.D., Philadelphia, Pennsylvania

IN two previous papers (1, 3) we have shown that the emptying time of the stomach of man and dog is markedly prolonged in the presence of a definite hypoproteinemias. In the dog the retardation of gastric emptying time occurred in the intact stomach and after various gastric short-circuiting operations, while in man we have studied this mechanism only in the presence of a gastric or duodenal lesion, and after gastric operations. In our studies the gastric emptying time varied inversely with the level of plasma protein. The implications of this relationship in surgical patients have been pointed out (5). The picture of obstruction in a patient who has recently undergone a gastric operation of the Billroth I or II type may be so striking as to suggest a mechanical defect, at the site of the new stoma, requiring a secondary operation, when in reality efforts directed toward a restoration of a normal serum protein level are more efficacious and not attended by so high a risk.

In the present study, we have studied the effect of hypoproteinemia on the small intestine. The methods employed were similar to

those reported in our previous papers. The plasma recovered by plasmapheresis was lyophilized by the method of Flosdorf and Mudd and retained under sterile conditions for intravenous infusion when it was desired to restore a normal serum protein concentration. The dogs were kept, for varying lengths of time, on a diet containing less than 1 per cent protein, but entirely adequate in every other respect including the known vitamins. In addition the animals were subjected to a variable number of plasmaphereses. Serum protein determinations were made upon each animal at frequent intervals. Gastro-intestinal studies were made at weekly intervals after the administration of a water-barium meal. The passage of barium through the small intestine was studied fluoroscopically and radiographically. Since the emptying of the small intestine was, in part at least, dependent on the emptying of the stomach, it was necessary to adopt some more independent index of motility. It was decided to take as an index of small intestinal motility the length of time required for barium to reach the cecum once a bolus had passed through the pylorus.

RESULTS

The first group of dogs was studied over a long period of time during which the blood proteins were reduced chiefly by diet. In each

From the Harrison Department of Surgical Research, Schools of Medicine, University of Pennsylvania, and the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia.
Submitted by Dr. Barden in partial fulfillment of the requirements for the degree of Doctor of the Medical Sciences, Graduate School of Medicine, University of Pennsylvania.
Dr. Thompson, Eli Lilly Fellow in Surgical Research.

Needless to say, it is a pleasure to recommend this volume to all medical students and to all practitioners who are interested in the subject of dermatology and syphilis as an excellent work from which the medical

student may grasp the fundamentals of dermatology and to which the practitioner may turn as a most valuable reference hand book.

E. A. OLIVER.

BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

ST THOMAS'S HOSPITAL REPORTS. Edited by Prof O L V S De Wesselow. Mr C Max Page assisted by Mr N R Barrett. Dr J St C Elkington. Dr A J Wrigley. 2d series. Vol 2. London: St Thomas's Hospital, 1937.

PHYSICIANS' VITAMIN REFERENCE BOOK. New York: E R Squibb & Sons, 1938.

J B MURPHY STORMY PETREL OF SURGERY. Loyal Davis M D. New York: G P Putnam's Sons, 1938.

THE DIAGNOSIS AND TREATMENT OF DISEASES OF THE BLOOD. By Thomas Ordway M D and L Whittington Gorham M D. Revised by Raphael Isaacs M D. London: New York and Toronto: Oxford University Press, 1937. (Reprinted from Oxford Monographs on Diagnosis and Treatment.)

X RAYS AND RADIUM IN THE TREATMENT OF DISEASES OF THE SKIN. By George M Mackee M D. 3d rev. ed. Philadelphia: Lea & Febiger, 1938.

THE TREATMENT OF CLINICAL AND LABORATORY DATA: AN INTRODUCTION TO STATISTICAL IDEAS AND METHODS FOR MEDICAL AND DENTAL WORKERS. By Donald MacLennan M B Ch B D Sc (Fdin). Edinburgh and London: Oliver and Boyd, 1938.

CORRESPONDENCE

THE FRANCIS AMORY SEPTENNIAL PRIZE OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

IN compliance with the requirements of a gift under the will of the late Francis Amory of Beverly, Massachusetts, the American Academy of Arts and Sciences announces the offer of a septennial prize for outstanding work with reference to the alleviation or cure of diseases affecting the human genital organs to be known as the Francis Amory Septennial Prize. The gift provides a fund the income of which may be awarded for conspicuously meritorious contributions to the field of knowledge during the said septennial period next preceding any award thereof through experiment, study or otherwise in the diseases of the human sexual generative organs in general. The prize may

be awarded to any individual or individuals for work of extraordinary or exceptional merit in his field.

In case there is work of a quality to warrant it the first award will be made in 1940. The total amount of the award will exceed ten thousand dollars and may be given in one or more awards. It rests solely with the discretion of the Academy whether an award shall be made at the end of any given seven year period and also whether on any occasion the prize shall be awarded to more than a single individual.

While there will be no formal nominations and no formal essays or treatises will be required the Committee invites suggestions which should be made to the Amory Fund Committee care of the American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts U S A.



Fig 7

Fig 8

Fig 9

Fig 7 Small intestinal pattern—water-barium meal in a normal dog.

Fig 8 Small intestinal pattern—after water-barium meal in animal which has become hypoproteinemic.

Fig 9 Small intestinal pattern—water-barium meal in an animal showing nutritional edema

In the first group, when the hypoproteinemic animals were placed upon a high protein diet, the gastric emptying and small intestinal motility quickly returned to normal. In the second group of animals, the same effect was produced by transfusions of the plasma which had been removed during the plasmapheresis.

The tissue edema which was shown to be chiefly responsible for the delay in gastric emptying time in our earlier experiments is, we believe, the chief factor in producing the retardation in motility of the small intestine.

During the present study it was found that the pattern of the barium-filled small intestine became quite bizarre and abnormal as the concentration of the serum proteins fell, and that this pattern was a reflection of the altered physiology in the small intestine, associated with the hypoproteinemic state. This observation merely emphasizes the importance of the small intestinal pattern as a reflection of systemic disease, a relationship which has been discussed in several recent papers (4, 6). Figures 7, 8, and 9 show this change as it occurred in one of our animals.

CONCLUSION

The present paper extends our former study of the relation of serum protein concentrations

to gastro-intestinal activity. It has been demonstrated that a reduction in the concentration of the serum proteins is associated with a marked retardation of the passage of a water-barium meal through the small intestine of the dog. Concomitant with this physiological change there is an anatomical change, as evidenced by the change in the intestinal pattern. Both these alterations from the normal can be corrected by restoring the serum protein to a normal level either by diet or transfusions of lyophilized plasma.

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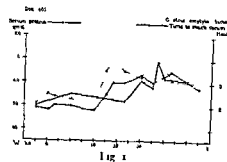


Fig 1

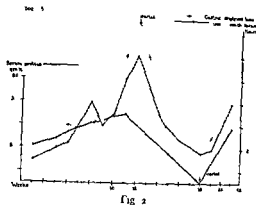


Fig 2

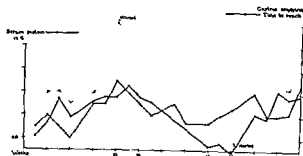


Fig 3

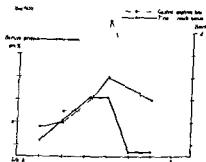


Fig 4

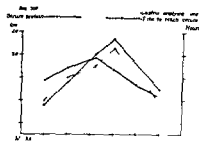


Fig 5

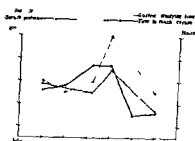


Fig 6

Figs 1 to 6 Relation ship between the serum proteins the gastric emptying time and the small intestinal motility H.P.D.—high protein diet L.P.D.—low protein diet

instance, the gastric emptying time behaved as we had been led to expect from our previous studies. The charts, Figures 1, 2, and 3 compare the serum protein concentration with the gastric emptying time and time necessary for a barium meal to reach the cecum. It was found that on a protracted low protein diet the animals lost weight at times developed ulcers, and were prone to lose their hair. This occurred even though adequate amounts of vitamin A and the B complex were present in the diet.

In order to eliminate the effect of an unrecognized dietary factor at work over a long period of protein restriction, a second group of dogs was rapidly rendered hypoproteinemc. This was accomplished largely by repeated plasmaphereses although the animals were placed on the low protein diet. Figures 4, 5, and 6 demonstrate the same constant relationship between the serum proteins and the small intestinal motility. Unlike the previous group these dogs were in excellent condition throughout the period of the experiment.



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NON-INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

CHARLES SUMMERS STEVENSON M D Baltimore Maryland

ELEMER SCIPIADES, Jr, M D, Budapest, Hungary

A STUDY of the most recent and best results of radiative and operative treatment of cervical cancer shows that, by and large, not more than one quarter of the cases are cured. Statistics reveal that cancer is the second most frequent cause of death in the Western World and that carcinoma of the uterus is responsible for about one third of the deaths from cancer in women.

In approximately 90 per cent of these cases it arises in the portio of the cervix, an organ which, like the tongue, skin and penis can be not only readily seen but also carefully scrutinized in a few minutes during the course of a routine physical examination. As has been reiterated, the operative and radiative types of therapy for this kind of carcinoma have about reached their peak of development and give no promise of any great further advancement in the near future. The most favorable statistics show that in those cases in which the cancer is still definitely limited to the cervix at the time radiative therapy is instituted about 52 per cent (Ward and Sackett) may gain a 5 year cure. This is accomplished only with frequent and careful check on their progress and with further radiation when required.

The average for several similar groups of cases given surgical treatment or combinations of both forms gives about a 50 per cent cure. In advanced cases one fifth or less are alive after 5 years (30-25). The inference from this is as Celsus is credited with having pointed out about 30 A.D. that the earlier in the course of the disease the diagnosis can be made the better the chance for cure. With the view of trying to assemble and study as large a group of early carcinomas as possible this work was undertaken.

From the Department of Gynecology of the Johns Hopkins Hospital and University.

Dr. Scipules, interne at the Seco d Women's Clinic of the Peter Pázmány University Hospital Budapest Hungary.

HISTORICAL

Cancer research was first centered upon the question of etiology, but none could be found comparable to the specific causal relationship of the gonococcus to gonorrhea. Research then turned, especially with those working on cervical carcinoma, to a study of the symptoms, and soon the asymptomatic phase was realized. The study of this, like that of prevention, brought investigators to consider the earliest forms of cancer.

The first mention of the general type of early cervical carcinoma with which this paper is concerned is found in the large work on carcinoma of the uterus by Schottlaender and Kermauner which was published in 1912. They noted the presence of a thin layer of surface carcinoma extending over the portio from the edge of a larger invasive growth. It completely replaced the normal epithelium, and was compared morphologically to the icing on a cake. These two workers considered it to be definite carcinoma and described its cells as being exactly similar to those of the main deep growth. They also mentioned its usual abrupt ending and junction with the normal stratified squamous epithelium of the portio. About 15 years ago Schiller who had worked under Kermauner began concentrated work on the genesis of tumors, and chose the cervix as his medium because of its accessibility and the frequency with which carcinoma develops there.

In his first paper on this subject published in 1927 (18), he points out the evidence against cervical carcinoma being caused by irritation. He describes what he calls beginning carcinoma of the cervix and states that it consists of a non invasive anaplastic epithelial growth usually located at the external os. Since the morphological characteristics of the cells are like those of the cells comprising an advanced carcinoma he designates these early non invasive lesions uncon-

ditionally as carcinoma. He also describes in detail the sharp and usually oblique border between the carcinoma and normal squamous epithelium, and mentions the frequent presence of vacuoles in those normal cells which are closely adjacent to the carcinomatous ones. He could find no evidence of precancerous cellular alteration, or of carcinoma in definite connection with erosion or repair. In the development of cancer he considers two changes, that of the surface epithelium into carcinoma, and, after a period, its invasion of the stroma. He describes the light superficial lymphocytic infiltration of the stroma beneath the surface carcinoma and believes it to be evidence of the conflict between the two types of tissue, the cancer cells, and those of the connective tissue. He believes that the normal cells lying immediately adjacent to the carcinomatous ones change very suddenly to cancer cells due to a "complete assimilatory metabolic change" resulting from the influence of the adjoining malignant cells. He feels that this change is irreversible and so rapid that no intermediary morphological stages are to be seen. General pathological opinion both here and in Europe does not completely support these hypotheses.

Schiller believes that metastasis may take place as soon as invasion has begun, and that all carcinomas, whether invasive or not, should receive radical treatment.

Contrary to Lahm's work, Schiller was unable to find *any* glycogen in carcinoma cells and so tried various stains with which to bring out this difference grossly. He finally was able to obtain good results using a weak aqueous iodine and potassium iodide solution (19). He points out (23) that although grossly these areas often differ little or none from the normal epithelium of the portio they are sometimes dull, white, opaque, and slightly wrinkled. In serial sections of cervixes from 425 panhysterectomies, Schiller found 6 incipient "carcinomas," an occurrence of 1.41 per cent.

The American literature covering the pathology of this type of early carcinoma of the cervix is rather meager. One of the first reported cases of early carcinoma was that of Cullen in 1921 (2). A few of the recent notable papers in this group are those of Novak (13,

14), Martzloff (9, 10), Norris, Broders, Pemberton and Smith (16, 17), TeLinde, Freedman, and Henriksen (5). Novak, Martzloff, and some others have held the view that as long as the intra-epithelial changes are not invasive, the lesion is not malignant, and since it is not malignant it cannot be called "cancer." On the other hand Graves, Smith and Pemberton, Broders, and some others have agreed with Schiller, believing that these growths are cancer as soon as the cells have assumed the morphological characteristics common to all cancer cells. Thus we find that pathologists are divided upon the questions as to whether these non-invasive lesions inevitably become invasive and as to whether they can legitimately be called cancer.

GENERAL DISCUSSION

The studies, begun by Schottlaender and Kermauner and carried on by Schiller, on early carcinoma of the cervix have been a great contribution and have called the attention of the medical world to this important pathological condition. There are many, as was previously stated, who do not agree with Schiller in his calling non-invasive growths definite cancer. Lubarsch, Frank, Menne, MacCallum, Novak (13), Martzloff (9), and others disagree with him on this point. However they do believe that these lesions are in some way related to carcinoma and may develop into the invasive destroying growth commonly recognized as cancer. It is their view that without heterotopia these lesions cannot be looked upon as cancer, as the inherent connotation and original meaning of this word is "an invasive destroying growth." In favor of their side of the question is the fact that the word "cancer" was used long before the individual characteristics of malignant cells were known. In addition, although "carcinoma" is a more recent term it has always been used synonymously with "cancer" when the growth was composed of malignant epithelial cells.

One of us (C S S) also agrees with the viewpoint that these non-invasive lesions definitely may become typical, destructive and invasive cancers, and suggests that they be called "non-invasive potential carcinomas"

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Fig 7, left Case 4 (Gyn Path. 27258). The "carcinoma" here has grown down into and lined a gland. The portion which covers the surface (upper right) is thinned out apparently due to the fact that the superficial spinal cells have been eroded away. In the gland they are intact and compose the major portion of the growth. A few of the spinal cells are multinucleated; the one at *A* is seen to contain 5 nuclei under the microscope. The basement membrane of the gland and the layer of basal cells of the "carcinoma" are intact. $\times 55$

Fig 8 Case 7 (Gyn Path. 30818). The "carcinoma" has grown into and lined a superficial gland. As in Figure 7 the superficial spinal cells remain intact and make up a large portion of the growth. Some fairly large hyperchromatic nuclei can be found in the superficial cells. $\times 50$

tissue from about four thousand cases, picking from them all those which had any suggestion of epithelial hyperactivity or anaplasia exclusive of the cases which showed invasive carcinoma. We then separated these into two groups, those in which the cells showed definite carcinomatous change and those in which we believed the epithelium to be merely hyperactive. As a result we had a few sections which appeared to show non-invasive "early carcinoma." Realizing, as Schottlaender, Ker-

mauner, and Schiller have pointed out, that any of these might be merely the surface edge of a large advanced carcinoma, we looked through our files for any further pathological material on these patients. As a result of this we found that several of the biopsies had come from the external os and had contained part of an outer extension from a larger carcinoma situated up in the cervical canal, or that they were taken from the edge of a small ulceration on the portio, which on shortly repeated

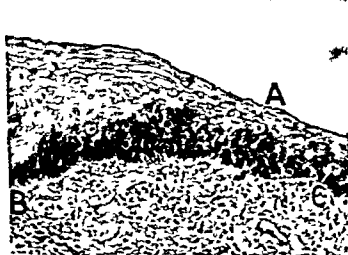


Fig 9



Fig 10

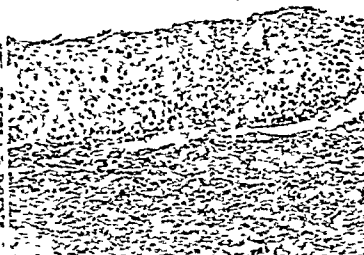


Fig 11

Fig 9 Case 12 (Gyn Path. 40282). This is a relatively high power photomicrograph showing the detail of a typical oblique border between the "carcinoma" (on the right) and the normal stratified squamous epithelium (on the left). The hyperchromatism of the lesion is marked and causes it to stand out sharply from the adjacent normal cells. The border is much more oblique than usual, the superficial part begins at *A* and the basal part extends far laterally under the normal epithelium to *B*. A large mitotic figure is seen at *C*. $\times 95$

Fig 10. Case 13 (Gyn. Path. 40900). The lesion is characterized chiefly by the large variously shaped dark staining nuclei scattered among many similar sized or smaller light staining ones. A few of the superficial nuclei are large and darkly stained. $\times 55$

Fig 11 Case 13 (Gyn Path. 41429). This is another biopsy section, taken 5 months after that shown in Figure 10. The general appearance is similar to that of the biopsy specimen taken from the same patient 5 months previously, the same "level" of activity being present. $\times 55$



Fig 1



Fig 2



Fig 3

Fig 1 Case 2 (Gyn Path 25171) The lesion is essentially limited to the squamous epithelium to the left of the gland mouth A The sharply cut edge of the carcinoma at the extreme left has curled inwardly probably in the fixing solution $\times 25$

Fig 2 Case 2 (Gyn Path 25171) The nearly complete absence of stratification the intact basal layer of cells and

the closely packed large anaplastic epithelial cells denote the lesion $\times 75$

Fig 3 Case 2 (Gyn Path 25171) Despite the thickness of the section some large 'black' nuclei can be seen with much smaller light staining ones nearby At the upper left corner the most superficial cells are seen to contain large very darkly stained nuclei $\times 300$

of the cervix The large invasive carcinomas which developed, as will be described, in two of our cases following the biopsy which showed them in their non invasive but potential state, coupled with the few other similar known cases, are evidences in favor of this view

The other writer of this article (E S Jr) believes, with Schiller and his adherents, that the presence of the malignant morphological characteristics in the individual cells comprising these lesions is sufficient for the unqualified pathological diagnosis of carcinoma of the cervix, the presence or absence of invasion being of no practical diagnostic importance The fact that many cervixes from

which the original biopsy contained a non invasive "carcinoma," on serial sectioning show a few small tongues of invasion, points, he believes to the danger of not calling them carcinoma These two viewpoints are illustrative of the differences of opinion among various workers on cancer problems

METHOD

On the basis of the present knowledge of this subject, we recently undertook to examine all the cervical tissue in the files of the Gynecological Pathology Laboratory of the Johns Hopkins Hospital We carefully studied some ten thousand microscopic sections of cervical



Fig 4



Fig 5

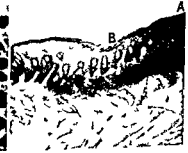


Fig 6

Fig 4 Case 2 (Kelly Hospital Path 13414) This is a typical section of the large invasive carcinoma which developed after 8 years apparently from remains of non invasive potential carcinoma pictured in Figures 1 2 and 3 $\times 65$

Fig 5 Case 2 (Kelly Hosp Path 13414) High power detail of the carcinoma in Figure 4 Note the large round and oval darkly stained nuclei similar to those in Figure 3 $\times 265$

Fig 6 Case 3 (Gyn Path 26010) The carcinoma extends through A to B and is separated from the normal squamous epithelium by a fairly sharp border Of chief interest in this section is the dense localized infiltration of lymphocytes in the stroma which are present just beneath the lesion and which extend a short distance laterally beyond it $\times 18$



Fig 7, left Case 4 (Gyn Path 27258) The "carcinoma" here has grown down into and lined a gland. The portion which covers the surface (upper right) is thinned out apparently due to the fact that the superficial spinal cells have been eroded away. In the gland they are intact and compose the major portion of the growth. A few of the spinal cells are multinucleated; the one at A is seen to contain 5 nuclei under the microscope. The basement membrane of the gland and the layer of basal cells of the "carcinoma" are intact. $\times 55$

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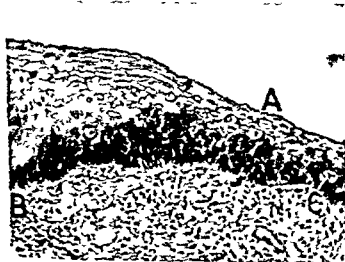


Fig 9



Fig 10

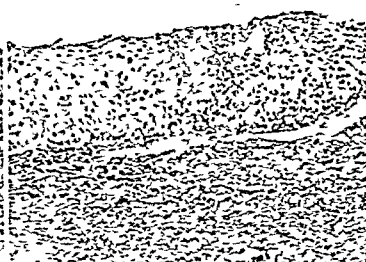


Fig 11

Fig 9 Case 12 (Gyn Path 40282) This is a relatively high power photomicrograph showing the detail of a typical oblique border between the "carcinoma" (on the right) and the normal stratified squamous epithelium (on the left). The hyperchromatosis of the lesion is marked and causes it to stand out sharply from the adjacent normal cells. The border is much more oblique than usual; the superficial part begins at A and the basal part extends far laterally under the normal epithelium to B. A large mitotic figure is seen at C. $\times 95$

Fig 10 Case 13 (Gyn Path 40900) The lesion is characterized chiefly by the large variously shaped dark staining nuclei scattered among many similar sized or smaller light staining ones. A few of the superficial nuclei are large and darkly stained. $\times 55$

Fig 11 Case 13 (Gyn Path 41429). This is another biopsy section, taken 5 months after that shown in Figure 10. The general appearance is similar to that of the biopsy specimen taken from the same patient 5 months previously, the same "level" of activity being present. $\times 55$



Fig 12



Fig 13

Fig 14

Fig 12 Case 13 (Gyn Path 45520) This section is through the anterior lip of the cervix. The carcinoma covers the entire portio extending from the general region of the external os (lower right corner) out over the surface almost to the vaginal wall (upper left corner). No points of invasion are seen $\times 20$.

Fig 13 Case 13 (Gyn Path 45520) This is a typical part of the superficial carcinoma which covers the portio of both the anterior and posterior lips of the cervix. This field was taken from a point 2 millimeters from the area shown in Figure 14. This carcinoma when compared to those in Figures 10 and 11 is seen to bear a striking re-

semblance to the lesions found in these biopsy specimens taken 2½ and 3 years previously from the same cervix $\times 70$.

Fig 14 Case 13 (Gyn Path 45520) This field is from the posterior lip of the cervix and is in the same section as the field shown in Figure 13. The surface (upper left) is covered with somewhat inactive and eroded superficial carcinoma. There is a fairly large tongue of quite active carcinoma growing into the stroma from the surface. Its component cells show not only the anaplastic characteristics of those in the original surface lesion but in addition there are many mitoses and the hyperchromatism is more marked $\times 70$.

biopsy had been proved a moderately advanced carcinoma. Several cases were apparently bona fide non invasive "carcinomas," but had to be discarded when careful serial sectioning of the rest of the cervical tissue disclosed a few small tongues of early invasion. Thus, after submitting each case to an impartial study, only 18 remained which we could definitely classify as "non invasive"

carcinoma of the cervix. All of our diagnoses were very kindly checked and confirmed by Dr. Walter Schiller and Dr. Emil Novak.

Brief histories of the 18 cases follow with pathological description when important.

CASE 1 (Path 23772) F. L. aged 57 years. Patient had one child at 45 preceded by three spontaneous abortions. She was seen on February 21, 1918 and complained of complete uterine prolapse.



Fig 15



Fig 16



Fig 17

Fig 15 Case 13 (Gyn Path 45520) This is another section through the posterior lip. It shows the carcinoma covering the surface like icing on a cake, and at one point there is an invading tongue of actual carcinoma. The stroma contains several circumscribed masses of the growth which are identical in appearance with the tongue seen in Figure 14. In them the transitional cell predominates although the borders are composed of several layers of spindle cells $\times 16$.

Fig 16 Case 16 (Gyn Path 44092) This photograph includes the entire thickness of a non invasive carcinoma with the intact basal layer on the extreme right and the roughened surface on the extreme left. Five mitoses are

denoted by 1. The variations in the size, shape, and staining density of the nuclei is rather marked. There is practically no erosion of the surface as the atrophic spinal cells are still present and even their black pyknotic nuclei show more than the usual variation in size and shape $\times 190$.

Fig 17 Case 18 (Gyn Path 45133) The carcinoma here has been stripped away from its stroma and by some artifact of fixing or sectioning rotated so as to face an adjacent portion of the cervix (lower right). The large variably shaped extremely dark staining nuclei are very prominent and some of them are present in the most superficial cells. This finding is one nearly infallible characteristic of non invasive potential carcinoma $\times 95$.

for the last 6 months. She had worn a pessary for 2 years previous to this. Examination showed lacerations of the perineum and complete uterine prolapse. A trachelorrhaphy (Emmett), anterior and posterior colporrhaphy, and Wertheim suspension of the uterus were done. Pre-operative examination of the cervix had shown that it was slightly enlarged and edematous and that the portio was smooth and pink despite moderately deep transverse lacerations. The microscopic section from one trachelorrhaphy specimen (this V-shaped wedge is usually taken so as to include all of the laceration) shows a rather large block of tissue which has obviously been trimmed down. At one end of it a superficial gland opens to the surface, and around its mouth there is a very small localized non-invasive "carcinoma." Its cells are generally large and they show a marked variation in size and shape. Many, both large and small, are very deeply stained. Similarly, many are lightly stained regardless of size. The surface is slightly eroded, and the usual superficial, flat, atrophic spinal cells, in which the nuclear remains are normally marked by a small dark dot, are replaced by large cells which contain large round or oval nuclei and have rather indefinite cytoplasmic borders. In many instances a cell can be found which has a diameter four times that of its neighbor and their staining densities may be similar or at opposite extremes. The finding of about 12 mitoses per high power field indicates a relatively hyperactive growth. This patient died of hypertension with coronary thrombosis in November, 1935, at the age of 74 years. Either all of the growth was removed or that which remained did not become a cancer over a period of 17 years.

CASE 2 (Path 25171, K-13414) C. P., aged 28 years when first seen June 30, 1919. She had had 4 children and was "badly torn" with the last one 3 years before. She came in because of "bearing down pains" since the birth of her last baby, leucorrhea for the past year, and occasional slight spotty intermenstrual vaginal bleeding for this same period. Examination showed a relaxed vaginal outlet, rectocele, and lacerations of the cervix. She then had a trachelorrhaphy, posterior colporrhaphy, and appendectomy. Pre-operative examination showed the cervix to be enlarged, firmer than usual, and slightly elongated. It pointed in the vaginal axis due to retroposition of the uterus. There were deep transverse lacerations, more so on the left, and there was moderate eversion on both lips around the external os. The portio was smooth and clean. The microscopic section from one trachelorrhaphy specimen shows a junction of the cylindrical cervical epithelium and the squamous type on one surface. As Figure 1 shows, the carcinomatous cells are limited to a point on one side of the mouth of a large cervical gland, and there is the afore mentioned junction on the other side. The "carcinoma" is 0.5 millimeter long and its left edge is sharply cut off. This is either the result of trimming the block, or, since it looks as though it has curled in, may well be the edge of the specimen as re-

moved at operation. One thus might conclude that the non-invasive potential carcinoma extended out over the portio and all of it was not removed. The higher power microscopic detail is about the same as that in Case 1, and a rough idea of it can be obtained from Figures 2 and 3. Unhappily the section is a thick one and the photographs are not what they might be. The variations in nuclear sizes, shapes and staining densities are of average degree except that hyperchromatosis is rather marked in a few cells. There is no definite spindle-shaped basal cell, the round or oval nucleated transitional type comprising nearly the entire thickness of the epithelium. Consequently, despite a few flattened superficial cells, there is a rather marked absence of stratification. The presence of about 8 mitoses per high power field indicates that it is a fairly hyperactive growth.

This patient next came to the hospital May 4, 1921, complaining of leucorrhea, backache, and profuse menstruation. At this time the cervix was smooth, firm, nearly flush with the vaginal vault, and there was a profuse leucorrhea exuding from the external os. A large ovarian retention cyst was found and removed. The cervix was not treated.

On February 28, 1928, she came to the hospital again complaining of continuous vaginal bleeding since the onset of her last recognizable menstrual period 4 months before. Examination disclosed a large cauliflower-like tumor replacing the cervix and filling the vaginal vault. It was friable, firm, and bled upon manipulation. There was thickening and induration of the vaginal vault and both broad ligaments half way laterally to the pelvic wall. In spite of radium treatment she died in a little over a year. A biopsy of this tumor (slide K-13414) shows several pieces of tissue made up of irregular large solid masses and thick columns of anaplastic epithelial cells (Fig. 4). These cells have predominantly large, round to oval nuclei which show all the variations seen in the original non-invasive growth. A high power field gives a picture (Fig. 5) generally similar with that of the earlier carcinoma, as a comparison of the two photomicrographs will disclose. The diagnosis here was "epidermoid carcinoma of the cervix, transitional cell type." Since the transitional type of cell predominated in both growths it may indicate that the relative degree of cell differentiation in the original anaplastic cells has not changed with invasion.

CASE 3 (Path 26010) M. M., aged 38. She had had one child and came to the hospital June 3, 1920, complaining of leucorrhea, backache, complete prolapse of the uterus for 3 years, and metrorrhagia for 5 weeks. Examination showed obesity and third degree uterine descensus. She had a conservative panhysterectomy and left oophorectomy. Pre-operative examination of the cervix showed it to be twice normal size, edematous, and tender. It was moderately deeply lacerated transversely and was eroded around the external os. A microscopic slide shows a cross section through one lip of the entire cervix. There is a non-invasive potential "carcinoma" which begins at

the external os and extends out over the lip for 8 millimeters. As Figure 6 poorly demonstrates the anaplastic cellular changes are marked the basal layer is intact and there is the usual oblique border. In addition there is a strikingly dense superficial infiltration of lymphocytes in the stroma as has been described by Schiller. In typical fashion it extends a short distance beyond the edge of the lesion, and the significance of this may be that the adjacent as yet non anaplastic cells are in some manner under the influence of the carcinomatous ones. The fact that they are morphologically normal and do not even show any structural evidences of hyperactivity does not exclude the possible presence of a profound physiological change and some believe that such might be the case. Unfortunately all efforts to trace this patient proved fruitless.

CASE 4 (Path 27258) G V aged 46 years who had had 12 children and two abortions came to the hospital complaining of severe lower abdominal pain, leucorrhea and dysuria for 1 month. Examination showed a relaxed vaginal outlet. She had a trachelorrhaphy and an anterior and posterior colporrhaphy. Before operation the cervix was slightly enlarged and irregular but the portio was relatively smooth. There were very deep transverse lacerations extending out to the vaginal vault which bled on examination. A microscopic section of one trachelorrhaphy specimen shows a non invasive potential carcinoma beginning in the laceration exactly at the junction of the columnar and stratified squamous epithelium and it extends out over the portio for 6 millimeters. The nuclear variations in size shape and staining density are very marked (Fig. 7). The basal layer consists of about one layer of spindle cells and is intact. Superficial to this there are about two layers of the characteristically round nucleated transitional cells. The main epithelial thickness lies superficial to this and is made up of typical pinial cell which have a prominent and relatively large amount of grayish pink cytoplasm with rather definite cell borders. Their nuclei show marked anaplasia, as already mentioned and a few very large cells contain 5 and 6 nuclei clumped together in the center. Many mitoses can be found. As Figure 7 shows these anaplastic cells have grown down into a gland for a short distance. This phenomenon has been described by Nowak (13) Schiller and others and is no indication of invasion. This woman is alive and well and many biopsies of the now atrophic cervix have shown no suggestion of malignancy.

CASE 5 (Path 28559) M B aged 50 years upon being examined in the dispensary on May 2 1923 was found to have a cervical polyp. It was removed with the biopsy forceps. The microscopic slide shows a section through its entire length. There is a non invasive potential carcinoma 1 centimeter long on one surface well up and away from the base. It appears to arise about 6 millimeters from the cylindrical squamous cell junction and is chiefly apparent due to its marked hyperchromaticous. The section is too thick for photography but under the

microscope the malignant characteristics of the cells are obvious. The presence of about 16 mitoses per high power field denotes unusual hyperactivity. Some of the mitotic figures are tripolar and many show markedly uneven division of the chromosomes which, as Mendelsohn and others have pointed out is characteristic of malignant cells. This woman unfortunately could not be traced.

CASE 6 (Path 30583) J S aged 49 years a mother of 3 children came to the hospital on August 21, 1925. She complained of leucorrhea for 1 year and came to the hospital for verification of the diagnosis of cervical polyp made by her family physician. Examination revealed a polyp. It was resected and its base and the cervical canal were thoroughly cauterized with 30 per cent silver nitrate. Before operation the cervix had been very firm and normal in size and shape. A full length cross section of the polyp is found in the microscopic slide and it reveals a non invasive potential carcinoma 1 millimeter long which lies practically at the cylindrical squamous cell junction and extends down to the cut border at the base of the polyp. The woman is asymptomatic and recent biopsies of the cervix and scrapings from its canal show no evidence of malignancy.

CASE 7 (Path 30818) M C aged 38 years had had 4 children and 1 abortion and came to the hospital November 24 1925 complaining of moderate leucorrhea for 3 years and lower abdominal pain for 6 months. Examination revealed obesity and a relaxed vaginal outlet. A left sided trachelorrhaphy and an anterior vaginal repair were done. Before operation the cervix was described as being about normal in size and consistency and it was transversely lacerated more deeply on the left. The microscopic section of the tissue removed from the cervix shows the carcinoma to be practically limited to a shallow gland ingrowth (Fig. 8). It can be seen the growth is made up of relatively highly differentiated cell and roughly consists of equal amounts of transitional and spinal cells. While the lack of cell uniformity is not as striking as in some of the sections the wide differences in nuclear sizes and shapes are readily apparent. She is alive and well and has no symptoms suggestive of cervical carcinoma. In this case a biopsy cannot be obtained and we may thus assume that if all of the lesion was not removed the remaining portion has not become invasive after twelve years or has in some manner been destroyed.

CASE 8 (Path 31795) A B aged 56 years a mother of 6 children had had a hysterectomy 3 years before for uterine fibroids. She came to the hospital November 23 1926 complaining of leucorrhea for 3 years and slight post coital bleeding for 3 months. Examination showed the cervix (stump) to be slightly smaller than normal about 2 centimeters long and of average consistency. There was some erosion around the external os and a few lightly roughened dark red areas of erosion 7 millimeters in diameter were situated on both the anterior and posterior lips.

These bled slightly upon examination. Several biopsies of the portio were taken, the canal of the stump was curetted, and the cervix was thoroughly cauterized with the actual electrocautery. The section of the biopsied tissue contains a great many strips of stratified squamous epithelium and one wonders if any was left on the portio. The non-invasive potential "carcinoma" is limited to two of these strips, which, due to the hyperchromatosis, stand out sharply from the neighboring normal epithelium. This woman died of apoplexy at the age of 64, by which time she had not developed a gross clinical cervical carcinoma. If the growth was not either all removed or destroyed at the time of operation that which remained was non-invasive for 8 years at least.

CASE 9 (Path 33968) C. B., aged 34 years, a mother of two children, came to the hospital November 16, 1928, complaining of menorrhagia for 5 months and metrorrhagia for 2. Examination showed retroposition of the uterus and relaxation of the vaginal outlet. A trachelorrhaphy, anterior and posterior colporrhaphy, and suspension of the uterus were done. Pre-operative examination showed the cervix to be normal in size and consistency and slightly lacerated transversely. The microscopic slide of the trachelorrhaphy specimen contains several fragments of cervical tissue, 2 of which are partly covered by non-invasive "carcinoma." This patient is alive and well and has no symptoms of carcinoma of the cervix. A biopsy of the cervix cannot be obtained.

CASE 10 (Path 35546 and 35573). H. C., aged 34 years, a negress who claimed she had never been pregnant, and who had had gonorrhea recurring off and on since the age of 18, came to the dispensary February 11, 1930, complaining of menorrhagia for 1 year. She was found to have a large myomatous uterus and chronic salpingitis and had a hysterectomy and bilateral salpingectomy. Shortly after discharge the cervix was found to be slightly enlarged, soft, and roughened. There was some erosion of the portio around the os which bled following examination, there were superficial transverse lacerations. Several biopsy specimens were taken from the lacerations and the eroded areas. The microscopic section shows some semicircular fragments of cervical tissue, one of which is covered with a non-invasive potential "carcinoma." The nuclear variations are marked and there is some fairly obvious hyperchromatosis. The patient was given radium and is alive and well, and a small scarred nodule in the now contracted vaginal vault is all that marks the former location of the cervix. A biopsy shows only scar tissue covered with a very thin layer of markedly atrophic squamous epithelium.

CASE 11 (Path 35996) E. W., a 27 year old mother of 5 children, came to the hospital July 7, 1930, complaining of post-coital bleeding for 1 month. The cervix was of about normal size and shape, but was softer than usual. There was "a reddened area on the anterior lip" from which several biopsy specimens were taken. Under the microscope

one of the several fragments was found to be covered with a non-invasive "carcinoma." This patient was alive and well and without any symptoms of cervical carcinoma in July, 1936. She has never received any treatment for the lesion and at present cannot be located.

CASE 12. (Path. 40282) D. B., a 61 year old mother of 5 children, came to the hospital November 2, 1933, complaining of complete uterine descensus for 5 months. She had a Watkins interposition operation and a low cervical amputation. Before operation the cervix was found to be small, softer than normal, and bilaterally lacerated. The portio was smooth and there was slight eversion around the os. The microscopic slide includes a full sized section from each lip of the cervix. On one lip, for a distance of 1 millimeter, there is a non-invasive potential "carcinoma" which, due to its marked anaplasia, stands out sharply from the adjacent benign epithelium. At one edge (Fig 9) there is a typical sharp oblique border. The "carcinoma" shows an extreme degree of hyperactivity, there being about 27 mitoses per high power field over one area. This woman is alive and well, and the cervical stump looks normal. Biopsies from it and scrapings from the canal show no evidence of malignancy.

CASE 13 (Path 40900, 41429, and 45520). M. S., a 34 year old mentally retarded woman who had had 2 abortions, came to the hospital July 31, 1934, complaining of dyspareunia of 2 years' duration. She had contracted gonorrhea at the age of 21 years, following which she had had a bilateral salpingo-oophorectomy with its subsequent surgical menopause. The cervix was found to be small and of normal consistency. There were deep transverse lacerations, and the portio was otherwise smooth and normal except for a slight perioral reddening. Several biopsies were taken around the os. The microscopic slide of these shows two fragments of cervical tissue, the surface of one being partially covered by a non-invasive potential "carcinoma" (Fig 10) which totals 3 millimeters in length. The cells show an average amount of malignant anaplasia manifested chiefly by the wide variations in nuclear sizes and shapes. The variations of staining density are of average diversity and there is a moderate amount of hyperchromatosis. The growth looks very inactive and only one mitotic figure can be found. There is a moderate infiltration of lymphocytes in the stroma beneath the lesion. At that time the slide was considered suspicious but the patient refused to allow further biopsy and left the hospital. She returned January 8, 1935, complaining of lower abdominal pain. The cervix was found to be as it was 5 months previously except that now the portio was smooth and normally pink. Biopsy specimens were again obtained from the cervix and the canal was curetted, but the scraping produced no tissue. Under the microscope the fragments of cervical tissue were found to be normal except that the surface of one of them was covered with a 4 millimeter length of non-invasive potential "carcinoma." A small piece of

the external os and extends out over the lip for 8 millimeters. As Figure 6 poorly demonstrates, the anaplastic cellular changes are marked the basal layer is intact and there is the usual oblique border. In addition there is a strikingly dense superficial infiltration of lymphocytes in the stroma as has been described by Schiller. In typical fashion it extends a short distance beyond the edge of the lesion, and the significance of this may be that the adjacent as yet non anaplastic cell are in some manner under the influence of the 'carcinomatous' ones. The fact that they are morphologically normal and do not even show any structural evidences of hyperactivity does not exclude the possible presence of a profound physiological change and some believe that such might be the case. Unfortunately all efforts to trace this patient proved fruitless.

CASE 4 (Path 27258) G V aged 46 years, who had had 12 children and two abortions, came to the hospital complaining of severe lower abdominal pain, leucorrhea and dysuria for 1 month. Examination showed a relaxed vaginal outlet. She had a trachelorrhaphy and an anterior and posterior colporrhaphy. Before operation the cervix was slightly enlarged and irregular, but the portio was relatively smooth. There were very deep transverse lacerations extending out to the vaginal vault, which bled on examination. A microscopic section of one trachelorrhaphy specimen shows a non invasive potential carcinoma beginning in the laceration exactly at the junction of the columnar and stratified squamous epithelium and it extends out over the portio for 6 millimeters. The nuclear variations in size, shape and staining density are very marked (Fig 7). The basal layer consists of about one layer of spindle cells and is intact. Superficial to this there are about two layers of the characteristically round nucleated transitional cells. The main epithelial thickness lies superficial to this and is made up of typical spinal cells which have a prominent and relatively large amount of grayish pink cytoplasm with rather definite cell borders. Their nuclei show marked anaplasia as already mentioned and a few very large cells contain 5 and 6 nuclei clumped together in the center. Many mitoses can be found. As Figure 7 shows these anaplastic cells have grown down into a gland for a short distance. This phenomenon has been described by Novak (13). Schiller and others and is no indication of invasion. This woman is alive and well and many biopsies of the now atrophic cervix have shown no suggestion of malignancy.

CASE 5 (Path 28559) M B aged 50 years upon being examined in the dispensary on May 2, 1923, was found to have a cervical polyp. It was removed with the biopsy forceps. The microscopic slide shows a section through its entire length. There is a non invasive potential carcinoma 1 centimeter long on one surface well up and away from the base. It appears to arise about 6 millimeters from the cylindrical squamous cell junction and is chiefly apparent due to its marked hyperchromatism. The section is too thick for photography but under the

microscope the malignant characteristics of the cells are obvious. The presence of about 16 mitoses per high power field denotes unusual hyperactivity. Some of the mitotic figures are tripolar and many show markedly uneven division of the chromosomes which as Mendelsohn and others have pointed out is characteristic of malignant cell. This woman unfortunately could not be traced.

CASE 6 (Path 30583) J S aged 49 years a mother of 3 children came to the hospital on August 21, 1925. She complained of leucorrhea for 1 year and came to the hospital for verification of the diagnosis of cervical polyp made by her family physician. Examination revealed a polyp. It was resected and its base and the cervical canal were thoroughly cauterized with 30 per cent silver nitrate. Before operation the cervix had been very firm and normal in size and shape. A full length cross section of the polyp is found in the microscopic slide and it reveals a non invasive potential carcinoma 1 millimeter long which lies practically at the cylindrical squamous cell junction and extends down to the cut border at the base of the polyp. The woman is asymptomatic and recent biopsies of the cervix and scrapings from its canal show no evidence of malignancy.

CASE 7 (Path 30818) M C aged 38 years had had 4 children and 1 abortion and came to the hospital November 24, 1925 complaining of moderate leucorrhea for 3 years and lower abdominal pain for 6 months. Examination revealed obesity and a relaxed vaginal outlet. A left sided trachelorrhaphy and an anterior vaginal repair were done. Before operation the cervix was described as being about normal in size and consistency and it was transversely lacerated more deeply on the left. The microscopic section of the tissue removed from the cervix shows the carcinoma to be practically limited to a shallow gland (ingrowth) (Fig 8). As can be seen the growth is made up of relatively highly differentiated cells and roughly consists of equal amounts of transitional and spinal cells. While the lack of cell uniformity is not as striking as in some of the sections the wide differences in nuclear sizes and shapes are readily apparent. She is alive and well and has no symptoms suggestive of cervical carcinoma. In this case a biopsy cannot be obtained and we may thus assume that if all of the lesion was not removed the remaining portion has not become invasive after twelve years or has in some manner been destroyed.

CASE 8 (Path 31295) A B aged 56 years a mother of 6 children had had a hysterectomy 3 years before for uterine fibroids. She came to the hospital November 23, 1926 complaining of leucorrhea for 3 years and slight post coital bleeding for 3 months. Examination showed the cervix (stump) to be slightly smaller than normal about 2 centimeters long and of average consistency. There was some erythema around the external os and a few slightly roughened dark red areas of erosion 7 millimeters in diameter were situated on both the anterior and posterior lip.

had an amputation of the cervix, an anterior and posterior colporrhaphy, and a dilatation and curettage. Before operation the cervix was found to be small, firm, and bilaterally lacerated. The portio was clean, smooth, and pink, except for very slight injection around the os. Careful gross examination of the cervix with a magnifying glass after operation disclosed no peculiar conditions of the portio epithelium, even though we knew from the section the position of the "carcinoma" around the os. The microscopic slide contained a section from each lip of the cervix. A non-invasive potential "carcinoma" was found at the external os on the anterior lip, and, in a thin layer, it extended out over the portio for nearly 1 centimeter. This woman was given radium, and a recent biopsy examination of the cervical stump showed no evidence of malignancy.

CASE 18 (Path 45133). N. S., aged 56 years, who had had two children and three miscarriages, came to the hospital June 11, 1937, complaining of a "sore growth at the outlet of the bladder," dysuria, a persistent slight vaginal discharge, and "a feeling as though the womb was falling out" of the pelvis. Examination disclosed chronic inflammation and some prolapse of the urethral mucosa, a relaxed vaginal outlet with cystocele and rectocele, and slight descensus of the uterus. The cervix was small, roughened, and irregular, and transversely lacerated. The portio was generally injected and there was a zone around the os which was sunken, granular, irregular, red, and which bled easily on examination. Several biopsy examinations were taken from this perioral zone of erosion. The microscopic slide showed three small fragments of cervical tissue, near one of which there was a detached, thin strip of non-invasive potential "carcinoma" 2 millimeters long (Fig. 17). The hyperchromatic nuclei cause it to stand out sharply from the normal squamous epithelium of the neighboring fragments. There was only about one mitosis per high power field. This patient was given radium and thus far has shown no evidence of the persistence of the lesion.

An analysis of these 18 cases shows that all the women were or had been married; 41 per cent were under the age of 40, and their average age was 46 years when the carcinoma was first discovered. The two extremes in age were 27 and 62 years. The menstrual onsets included the ages of 12 through 16, the average age being 14 years. Seven of the patients were beyond normal menopause, the average time being 7 years. One had had a surgical menopause as the result of a bilateral salpingo-oophorectomy, 2 had had hysterectomies. Five had had some dysmenorrhea. In all cases the menstrual durations and intervals were within normal limits. All but one woman had been pregnant, and the series had had a total

of 53 babies and 14 abortions, an average of 3.0 babies and 0.8 abortions per woman or 3.8 pregnancies. One woman had had 12 babies and 3 had had only 1. Four women had had prolapse of the uterus, 2 with procidentia and 2 with second degree; 3 of these had worn pessaries. Three had had gonorrhea; 1 had also had buboes. The mother of 1 woman had died of cancer. Nine, or 50 per cent, complained of leucorrhea. Seven had had metrorrhagia, and in 2 of these it had been post-coital. Three women were found to have retroposition of the uterus.

Seven came to the hospital because of slight metrorrhagia (9 cervixes showed eversion or erosion and 7 bled upon examination), 4 came because of prolapse of the uterus, and 2 came because of lower abdominal pain and leucorrhea. One woman came for each of the following causes: infectious arthritis, dysuria, dyspareunia, menorrhagia apparently due to uterine myomas, and for verification of the diagnosis of cervical polyp made by her family physician.

Thirteen of the cervixes, or 72 per cent, were transversely lacerated, and in 3 of these the lacerations were very deep and extended down to the vaginal wall. Thirteen cervixes showed eversion, erosion, or some injection around the os, while 4 were hypertrophied. In 3 cases the "carcinoma" was found in a cervical stump. The original pathological diagnosis in 9 cases was "epidermoid carcinoma of cervix," while in 7 it was "chronic cervicitis"; both polyps were called benign. As far as we were able to determine, from making serial sections of all available tissue on these cases, all of the growth was apparently removed with the specimen in 4 of the 5 trachelorrhaphies, the 2 amputations, and the 1 panhysterectomy. In 9 of the 11 other patients subjected merely to biopsy, sectioning of the remaining available tissue did not allow us to make up our minds definitely on this point, although in one instance it might well have all been removed (Case 8). Five of the "carcinomas" were found in the V-shaped wedge of cervical tissue removed when the trachelorrhaphy was done.

In most of Schiller's cases the growth has been found centered at the external os at the

stroma remained attached to it and was infiltrated with lymphocytes (Fig 11). The anaplasia of the cells was marked and the general picture was identical with that seen 5 months previously. The same activity level prevailed as no mitoses could be found.

This woman again refused any treatment and returned to her home in one of the Southern states. When we finally located her she was extremely ill with pernicious anemia but was without any symptoms of cervical cancer. She died of the anemia July 15, 1937, and we were very fortunate to obtain the cervix for pathological study. Grossly it was normal in size, shape and consistency and the portio appeared to be smooth and shiny to the unaided eye. On section it showed nothing unusual. It was cut serially into blocks from each of which microscopic sections were made. One of these (Fig 12) showed the anterior lip of the cervix to be nearly entirely covered even out to the vaginal vault with non-invasive carcinoma. A section from the posterior lip (Fig 13) showed the non-invasive carcinoma again covering the portio but here (Fig 14) there was also a tongue of apparently fresh invasion extending from it into the stroma. The non-invasive portion on the surface (Fig 13) was identical in appearance with the biopsy specimen taken 3 years (Fig 10) and 2½ years (Fig 11) previous to the patient's death and it likewise shows no mitoses. In contrast the cells comprising the invasive tongue are larger, more "active" in appearance and quite a few mitoses are readily found. Other sections through the posterior lip of the cervix show somewhat similar tongues of invasion and in addition the body of the cervix contains many bundles of the same carcinoma (Fig 15). Thus we have a case of asymptomatic carcinoma of the cervix in which invasion from the pre-existent non-invasive lesion probably began an estimated 2 to 4 months before the death of the patient. Unfortunately an autopsy could not be done on this case and we do not know if there were any metastases or extensions of the growth into the parametrial tissue. It is the opinion of her attending physicians that her death was due entirely to refractory pernicious anemia.

CASE 14 (Path 42430) N. I., a 52 year old mother of two children, came to the hospital complaining of joint pains for 9 months and was found to have infectious arthritis. She was referred to the gynecology department for a pelvic check up with regard to a possible focal infection there. Examination showed that the cervix was about normal in size, shape and consistency. The anterior lip was smooth but the posterior lip was slightly adherent to the posterior vaginal wall and these adhesions were injected and bled slightly following examination. Biopsy specimens were taken from both lips. The microscopic section showed two fragments of cervical tissue one of which was covered on one side with normal stratified squamous epithelium and a very short length of thin non-invasive carcinoma. This patient was given radium directly to the portio and

is alive and well. Recent examination has shown no evidence of cervical carcinoma.

CASE 15 (Path 43321, 43366 and 43481) L. C., a 46 year old Russian Hebrew woman who had had one child and two abortions, came to the hospital May 6, 1936 complaining of metrorrhagia for 3 days 1 month before. She had had a subtotal hysterectomy at the age of 25 years and she had not menstruated since. Examination disclosed obesity, a hypertension of 220/150 and diabetes. The cervical stump was found to be small of normal shape and consistency and the portio was smooth except for a small circumscribed eroded area on the posterior lip which bled on examination. Several biopsy fragments were taken from the cervix and the microscopic slide contained several of these fragments of cervical tissue and a few small fragments of non-invasive potential carcinoma. She was given radium and was alive and well when last heard of in December, 1936. Further attempts to locate her have proved fruitless.

CASE 16 (Path 44092) J. S., a 62 year old nulliparous married Hebrew woman, came to the hospital November 5, 1936 complaining of very slight metrorrhagia for 8 months. On examination the cervix was found to be small, firm, of normal nulliparous contour and the portio was smooth except for several small areas of erosion on both the anterior and posterior lips. Several biopsy fragments of tissue were taken. The microscopic slide showed some fragments of cervical tissue and a strip of typical early non-invasive potential carcinoma 3 millimeters long. As can be seen in Figure 16 the anaplasia is very marked. The nuclei are greatly varied in shape, size and staining density. There are 10 mitoses per high power field. The basal layer is intact and consists of about three layers of spindle cells. Then about half of the thickness of the epithelium is made up of round or oval nucleated transitional cells and superficially these change over and somewhat resemble spinal cells. This latter change consists of a horn-like appearance and increased prominence of the cytoplasm with the nuclei becoming more generally oval but not decreasing in size. In this particular case there is a thin superficial layer of atrophic cells in which the nuclei are small, usually oval and take a dense dark stain. In most sections these cells cannot be found as they usually slough off as soon as they become atrophic. The transitional type of cell predominates although there is some semblance of stratification remaining. The mitoses are evenly distributed between the three viable layers and several are found in cells practically at the surface which is never seen in benign hyperactivity. This woman was given radium and is alive and well without any symptoms suggestive of cervical carcinoma.

CASE 17 (Path 44279) V. K., aged 61 years the mother of 5 children, came to the hospital December 14, 1936 complaining of uterine descensus for 3 months. Examination showed a relaxed vaginal outlet and a second degree uterine descensus. She had

vative potential "carcinoma" of the cervix is essential for accurate diagnosis. In the first place the component cells exhibit those signs generally accepted as characteristic of malignant cells. The nuclei, instead of showing the uniformity seen in normal stratified squamous epithelium, present a total absence of uniformity; they may be as much as six times the size of their neighboring nuclei, and may be round, oval, flattened, or slightly curved or twisted. Some nuclei will take practically no stain at all and their chromatin will stand out prominently like a lattice-work over a window; their nucleoli usually stain a bit darker and are relatively larger than those in the nuclei of benign cells. Other nuclei may be hyperchromatic, taking a dense "black" visually impenetrable hematoxylin stain. There may be all degrees of staining density between these two extremes, and there may be some intranuclear variations as well. The important point is that the nuclear staining densities bear no relation whatever to the size of the nuclei. In normal cells the larger the nucleus the lighter the stain and vice versa; in the malignant ones there may be an extremely large "black" nucleus in a cell which lies adjacent to one containing a pale staining nucleus one-sixth its size. There may be occasional large cells with a dozen nuclei in them. The cytoplasmic cell borders generally are not easily discernible and the cells lie in such a close-packed heterogeneous confusion that one receives the impression that there are a relatively greater number of nuclei per high power field than in normal epithelium. The presence of large darkly stained round or oval nuclei in cells on the surface of the growth is characteristic of this superficial "carcinoma," and the compact spinal cell outer layer is nearly always absent. The stratification of the cells normally seen in squamous epithelium is frequently absent although some definite semblance of it may remain.

The border between the normal epithelium and the "carcinoma" is nearly always sharp, and while in some cases it may be perpendicular, it is usually and characteristically of a 45 degree obliquity, the superficial portion leaning toward the new-growth. The basal

layer consists usually of more or less spindle shaped cells closely lined up in a single intact layer. Although there may be the same changes in the contour of the basal layer as are found in normal squamous epithelium, e.g., shallow tongues of cells dipping into the stroma, complete epidermization of a superficial gland, etc., the stroma must not be invaded. No specific changes in the elastic tissue of the stroma beneath these growths can be demonstrated (27).

These "carcinomatous" cells, as Best's stain will show, do not contain the glycogen found in the spinal and some superficial transitional cells in normal stratified squamous epithelium. There may be a characteristic lymphocytic infiltration in the stroma beneath and in that extending just beyond the border of the growth. The growth activity, as manifested by the relative number of mitoses per high power microscopic field, in our cases does not bear any definite relation to the relative degree of anaplasia of the cells. We wish especially to stress this fact. Many times we have observed as high as 6 mitoses per high power field in a perfectly benign tongue of epithelium in the process of growing into a superficial gland during the repair of an inflammatory cervical condition. In a rapidly advancing and enlarging cancer the cell multiplication rate must of necessity be very high, and a correspondingly large number of mitotic figures per high power field will naturally be found; here their presence is undoubtedly of some aid in making the microscopic diagnosis of malignancy. As a rule the presence or absence of mitotic figures in a non-invasive potential "carcinoma" of the cervix has been of little or no diagnostic value, and in the final analysis the diagnosis can be made only when the anaplastic nuclear changes and non-uniformity of cell arrangement described herein are present.

DEFINITION AND SIGNIFICANCE OF NON-INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

Non-invasive potential "carcinoma" of the cervix is a lesion composed of anaplastic epithelial cells which apparently arises spontaneously in a "growth center" at the junc-

junction of the cylindrical and squamous epithelium, and he has stressed this fact. This is further borne out by the finding of 11 of our non invasive potential "carcinomas" at the same junction, despite the fact that half of our lesions were found in biopsy fragments. Five of our "carcinomas" were found relatively localized to childbirth lacerations. We wish to draw attention to the fact that Smith and Pemberton's (17) 3 cases of early cervical "carcinoma" which later became invasive were found in tissue removed during trachelorrhaphy.

The microscopic pictures of these 18 cases were essentially similar in that the cells all showed typical anaplastic changes, all of the growths were non invasive and had lost most of the stratification seen in normal squamous epithelium, and all stood out rather sharply from the adjacent benign epithelium.

Case 2, in which the "carcinoma" became invasive after 8 years, and Case 13, in which invasion began about 3 years after biopsy, present some evidence that these non invasive "carcinomas," as Schiller believes, are potentially invasive. Smith and Pemberton's 3 cases are of similar significance. Since only 2 of our cases developed into clinical "cancers," one of which was later directly fatal, it might appear that the potential invasiveness of these lesions is questionable. However, as was stated above, in 7 of our cases all of the lesion was apparently removed. Of the 11 others 2 later developed into an invasive growth. Five of the cases in which biopsy was done were recognized as "carcinoma" and were given adequate radium treatment. Of the 4 cases remaining 2 patients were given thorough cervical cauterization following biopsy and in 1 of these all of the growth might well have been removed by the extensive stripping of the squamous epithelium from the portio and the curettage of the canal of the stump. Thus leaves 2 non invasive potential "carcinomas" apparently unaccounted for. Cases 5 and 11. We have not been able to follow Case 5 and in Case 11 the patient was alive and well when last heard from in July 1936.

The trachelorrhaphy specimen removed from Case 2, June 30 1919 showed non invasive "carcinoma," and when she was seen on

February 28, 1928, 8 years and 8 months later, she had an advanced carcinoma of the cervix. It had then been symptomatic for 4 months and when Stahler's mathematically evolved 27 month asymptomatic postinvasive period (28) is added it gives a 67 month invasive growth period to this tumor. In subtracting this from the total time interval a known non invasive existence of 8 years and 13 months is established. Case 13 showed early asymptomatic carcinoma in the posterior lip of the cervix at the time of death, 3 years after the first biopsy was taken. From the extent of the growth we might assume that invasion had taken place from 2 to 4 months before death, in which case we establish a known non invasive period of 2 years and 9 months for the original superficial lesion. By similar calculations Smith and Pemberton's (17) Case 1 had an established 3 year and 13 month non invasive period, with a 107 month invasive growth phase. If, on the basis of 6 months being the average duration of symptoms in large groups of cases (6) we assume 87 month invasive phases for his other 2 patients, Case 2 would have a non invasive period of 4 years and 03 months, while Case 16 would have one of 5 years and 43 months. Thus, from the data on these 5 cases, we find that the established known non invasive periods vary from 2 years and 9 months to 8 years and 1 month.

In our Case 11, in which the biopsy specimen taken in 1930 showed non invasive potential "carcinoma," the patient has as yet received no treatment and was well and without suggestive symptoms in July, 1936 exactly 6 years later. The 2 biopsy examinations in our Case 13 (Figs 10 and 11) show the same "level" of anaplasia and activity. When they are compared to a portion of the superficial growth (Fig 13) on the same cervix 3 years later a striking resemblance is still apparent even though by this time invasion has begun from the surface lesion about 2 millimeters away.

THE DIAGNOSIS OF NON INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

A full knowledge and understanding of the various elements which constitute non in

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tion of the squamous and columnar epithelium of the portio of the cervix. It lies within the usual domain of the normal stratified squamous epithelium and has remained relatively localized in a few accurately observed cases for from 3 to 8 years after which it may break through the basement membrane and invade and destroy the stroma of the cervix, having then become clinically a cancer.

The fact that some of these lesions apparently do not become invasive cancers suggests that possibly all are not potential "carcinomas." However, the possibility of the destruction of these superficial growths during their several years dormancy by the necroses and erosions of trauma and intercurrent infections looms rather formidably when carefully considered.

If all clinical cervical carcinomas are preceded by this non invasive phase, then routine biopsy of all cervixes even once a year might be a guarantee against the development of cervical cancer. Although we feel that in our Case 13 we have been able to demonstrate fairly well the growth continuity through the non invasive to the invasive phase we cannot say definitely that the invasive carcinoma in our Case 2 developed from the non invasive growth discovered 8 years previously. As W. G. MacCallum has stated "It is natural that the development of the carcinoma should be connected with the original change but it does not seem quite proven." (8) However, if a patient without symptoms is found repeatedly to have a growth of Escherichia coli in cultures of the urine from one kidney and after a period, has an acute flare up of pyelitis in that kidney, the urine giving a heavy growth of the same organism we naturally assume that the original bacillus was the cause of the acute inflammation.

Among the obvious questions raised by a consideration of these lesions are the following: Is every cervical cancer preceded by a non invasive phase of one or more years? Will every non invasive potential "carcinoma" of the cervix eventually invade the stroma if the woman lives long enough and the growth is not destroyed? What are the factors determining the breaking through of the stromal defenses by the anaplastic epithelial cells? If

some of these growths are not potentially invasive could they be differentiated from those that are? These and other queries on the subject will be answered only when many more of these cases are assembled and carefully studied.

SUMMARY

1. Cancer is the second most frequent cause of death in the western world, cancer of the uterus is responsible for one third of the cancer deaths in women. 90 per cent of uterine cancer arises in the portio of the cervix and is thus easily accessible for examination and study.

2. The most favorable statistics from the treatment of cancer when it is limited to the portio of the cervix show a 52 per cent cure while not more than 20 per cent of all cervical cancers have a 5 year cure.

3. Schottlaender and Kermanner (1912) and Schiller (1927) have described and called attention to a form of superficial non invasive cervical "carcinoma." Schiller considers and treats it as definite carcinoma.

4. The authors present 18 cases for which one of them (C. S. S.) has proposed the name "non invasive potential 'carcinoma' of the cervix."

5. In 1 patient (Case 2) the "carcinoma" remained non invasive for 8 years and 1 month, following which it developed into a clinical carcinoma and finally caused the death of the patient. A second patient (Case 13) died of pernicious anemia 3 years after the first biopsy examination revealed a non invasive potential "carcinoma." Serial sections of this cervix revealed that invasion had taken place shortly before death.

6. Non invasive potential "carcinoma" of the cervix is defined and its diagnosis is discussed as well.

7. The authors hope that similar studies of the material in other pathological laboratories will be carried out for when many of these cases are thus unearthed and studied we will be able to draw more valuable conclusions and to throw light on the as yet unanswerable questions on this subject.

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has been carried out with increasing frequency.

Forty-two of the 45 cases herein reported, were operated upon by us, 3 by other members of this surgical service. Thus, by close collaboration and frequent exchange of opinion, we developed the present operative technique and general mode of management of cases of acute pulmonary abscess. Of vital importance has been the co-operation of the physicians of our institution, who, noting the results which have been obtained in these cases, now request early surgical consultation.

In this communication our 45 cases shall be analyzed for the purpose of presenting, partly in detail and partly in outline, their varying etiology, their clinical and roentgenographic features, the operative problems and findings, the operative sequelæ, and the results of operative treatment.

Classification. Incidence For purposes of analysis and classification, the cases have been divided into two groups, unperforated and perforated. Thirty-four cases (Group A) were unperforated in the sense that the abscess was confined to the pulmonary parenchyma. In 11 cases (Group B), the complication of perforation into the pleura with pyopneumothorax existed prior to operation.

In our series the higher incidence of pulmonary abscess in males is to be noted (29 males, 16 females). An explanation will be offered in a succeeding paragraph. The youngest patient was 2 years of age, the oldest was 70. Thirty of the 45 cases occurred during the fourth, fifth, and sixth decades of life, the lowest incidence being noted at the extremes of life.

Location of lesions In the 45 cases, the right lung was involved in 32, the left in 12, and both right and left in 1. A single abscess was present in 40 of the 45 cases. In 15 of these, it was located in one of the upper lobes; and in 20, in one of the lower lobes. In 5 cases it involved contiguous portions of two adjacent lobes by direct extension across an interlobar fissure. There were 5 cases in which more than 1 abscess existed. Of these, 3 had 2 abscesses lying immediately adjacent to each other, the lesions being situated in the upper lobe in all 3 instances. (We regard these as

cases of solitary abscess in which more or less irregular extension into the adjacent pulmonary parenchyma had occurred.) In the fourth case (Case 37) there were 3 widely separated abscesses in the right lung. The last case (Case 45) presented several bilateral abscesses.

The point is that the great majority of patients had *single* lesions, a fact which supports the "*aspiration*" rather than the "*embolic*" theory of origin of putrid abscess of the lung. If the *embolic* mechanism were common, the pulmonary lesions frequently would be *multiple*, *widespread*, and *bilateral*. It is interesting, in this connection, to note that in the 1 case in this series (Case 45), in which an embolic mechanism properly could be invoked, the pulmonary lesions *were* multiple, widespread, and bilateral. A second fact, which suggests strongly that aspiration is responsible for the production of putrid abscess of the lung, is the much higher incidence of right sided as compared with left sided lesions in this series. The direct pathway from the trachea into the right main bronchus in contrast with the less direct one into the left main bronchus, would account for the preponderance of right sided lesions on the basis of aspiration.

Etiology. The etiology was definite in only 19 cases, as follows: tonsillectomy in 8 (2 under local anesthesia); extraction of teeth in 2 (both under local anesthesia); operations under general anesthesia in 2; incision of a peritonsillar abscess in 1; epileptic seizure in 1; acute tonsillitis in 1; spillover from a chronic pulmonary abscess in 1; sepsis after therapeutic abortion in 1; and laceration of the esophagus in 2. In these last 2 cases the pulmonary abscess was the result of direct extension of infection from the mediastinum into the adjacent lung.

In the 26 remaining cases the etiology was "uncertain." In a recent article, Stern¹ of this institution reported his investigation concerning the cause of putrid abscess of the lung in a series of cases of obscure etiology. In 84 per cent of cases in which the etiology was not obvious, he found gross gingivodental infection, and unusually large deposits of dental

¹Stern, L. Etiological factors in the pathogenesis of putrid abscess of the lung. J. Thoracic Surg., 1936, 6, 2, 202.

ACUTE PUTRID ABSCESS OF THE LUNG

II An Analysis of Forty-Five Consecutive Operative Cases

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IN a recent publication¹ we presented evidence in favor of operation in the *acute* stage of putrid abscess of the lung, based upon a study of the pathological and clinical features of the disease as observed in a large series of cases in all stages. Operative indications were discussed, our operative methods were described in detail, and the results obtained in the surgical treatment of 37 consecutive acute cases were outlined. We defined an "acute" abscess arbitrarily, on the basis of time alone, as one of not more than 6 weeks' duration from the time of onset of pulmonary manifestations. Some of the points which were emphasized and which have a bearing on the present communication, are as follows: (1) An understanding of the pathology of acute abscess of the lung constitutes the foundation of correct treatment, and in particular of correct operative treatment. (2) Certain pathological features such as the superficial location of the abscess within the lobe and the presence of overlying pleural adhesions, indicate the feasibility of operation in the acute stage. (3) The inflammatory process is well localized in the early phase. (4) In the later phases it becomes widespread and secondary changes occur in the surrounding pulmonary parenchyma and bronchial tree. These changes are responsible for the lower incidence of cure and the higher incidence of morbidity and mortality in the subacute and chronic cases. (5) Acute cases may be classified as 'mild' or 'grave'. Spontaneous subsidence may occur, less often in the latter than in the former. In those cases in which the process does not subside fatal complications develop early in the course of the disease or they pass into the chronic

phase. (6) The seriousness of putrid abscess of the lung can be appreciated only if the manifestations of the chronic phase and the complications with their mortality, are borne in mind. (7) Although clinical manifestations usually settle the question of operative intervention in individual cases, it can be stated, in general, that the great majority of patients with "grave" lesions should be subjected to operation in the acute stage. (8) The operative method which we advocate consists essentially of a single stage procedure in which the lesion is entered through overlying pleural adhesions, unroofed and packed. (9) Exact diagnostic localization of the lesion is a prerequisite for the operative methods which we employ. In the absence of precise pre-operative localization of the abscess, the operation as described is not recommended.

The present paper is based upon a study of 45 consecutive operative cases of acute putrid abscess of the lung,² treated in accordance with principles stated in our previous communication. These patients represent the total number treated by operation in a series of more than one hundred cases of acute putrid pulmonary abscess admitted to the Mount Sinai Hospital. Thus every acute case that has come under observation has not been operated upon. On the other hand, it is to be emphasized that in no instance was operation withheld from a gravely ill patient for fear of increasing the operative mortality rate.

We began to operate upon patients with acute pulmonary abscess in 1925. In the beginning operation was performed rarely and was reserved for patients who were desperately ill. In recent years, however, as our surgical indications have broadened, operation

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¹Neuhof H. and Touroff A. S. W. Acute putrid abscess of the lung: principles of operative treatment. *Br. J. Surg.* 1936 63: 333-368.

²Since this paper was prepared for publication, 23 additional patients have been operated upon with satisfactory results in 7 and death in 1 several months after operation from pulmonary complications not referable to the operated upon (and healed) acute pulmonary abscess.

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, age, sex, admission No.	Etiology Duration before admission	Pre operative course, special features	X-ray	Bronchoscopy	Location of lesion In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Inter course	Result
6 T S 1911 322,870 Male 37	Unknown 3 wks	Septic course, high fever, very rapid pulse, prostration Rapid enlargement of lesion	Extensive infiltration in upper part of R L L posteriorly	Poultice, apical branch R L L	Apical segment of R L L 10 days	One stage Local anesthesia Paravertebral approach through 7th rib and transverse process. Pleural adhesions. Very large cavity unroofed	Uneventful Discharged 3 wks after operation	Uneventful Bronchial fistula maintained for 5 weeks	Well 19-year follow up Symptom free Normal x ray
7 M C 1911 320,127 Female 16	Post tonsillectomy (general anesthesia) 11 days	High fever, septic course, rapid increase of pulmonary cavitation. Profuse expectoration	Diffuse pneumonic infiltration medial portion of base of R L L with cavity formation	Small amount of foul pus, posterior branch R L L	Medial segment R L L (mediastinophrenic aspect) 8 days	Two stages 1st stage Local anesthesia Posterolateral approach through 6th rib No parietal pleural adhesions present. Pleura opened and explored. Adhesions found in lower lobe under surface of lower lobe and diaphragm. Tendon shut off from free pleura by suture and packing	Uneventful except for irregular fever for 3 wks Discharged 33 days after operation	Uneventful Bronchial fistula maintained for 2 mos	Well 3½ year follow up Symptom free Normal x ray
8 J M 1911 328,417 Male 59	Indeterminate (poor dental and oral hygiene) 18 days	High fever, night sweats Rapid loss of weight	Uncomplicated pleural effusion in lateral half of chest apex to base	Not performed	Posterolateral segment R L L 5 days	One stage Local anesthesia Posterolateral approach through 7th rib. Pleural adhesions present. Large cavity unroofed. This lesion was unroofed compared with the empyema seen by x ray. Pleura aspirated in 6th interspace. Foul pus obtained. 6th rib resected and large putrid empyema evacuated. No communication between abscess of lung and empyema. Not a case of perforated lung abscess	Uneventful Discharged 21 days after operation	Uneventful Bronchial fistula maintained for 2 wks	Well 3 months follow up Failed to return thereafter. When last seen was symptom free. Wound healing. X ray negative except for slight residual pleural thickening

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, age, admission No.	Sex	History Duration before admission	Pre operative course, special features	X ray	Bronchoscopy	Location of lesion In hospital before operation	Operative procedure, and findings	Postoperative course (in hospital), special features	Inter course	Result
15 1031 365,580 Female 2	Male 36	Indeterminate (poor dental hygiene) 1 wk	Proliferative hemoptysis at onset	Dense shadow in right portion of chest. No cavity visible	Found pus, an abscess in the right bronchus L.U.L.	Axillary segment L.U.L. 7 days	One stage. Avertin G.O. in thorax. Posterior approach through 4th rib. No pleural adhesions found. Pleural adhesions found at lower level. Pleural adhesions 5th rib resected. Pleural adhesions 1 in cavity in lung unroofed. Several accessory loculations present.	Uneventful. Discharged 12 days after operation	Uneventful. Bronchial fistula maintained for 2 mos	Well. 3 yr follow-up. Symptom free. Normal x ray
16 1031 376,581 Female 2	Male 36	Indeterminate (poor dental hygiene) 4 wks	Unimproving course. High fever. Marked toxemia. Rapid enlargement of cavity	Dense pneumonic infiltration—lateral portion of L.U.L. Several fluid levels	Not performed	Axillary segment L.U.L. 1 day	One stage. Local anesthesia. Axillary approach through 5th rib. Free pleural adhesions cut. Adhesions adjacent to pleural adhesions. Lung surface to thoracic parietal pleura unroofed. Large cavity unroofed. After first operation, reoperation.	Postoperative fever. Prostration. Non-foul expectoration. X-ray revealed unroofed abscess lying posterior to the drained cavity	Satisfactory except for occasional bloody expectoration during early course	Successful 1 mos after operation. Bronchial fistula was being maintained. Normal x ray and symptom-free at time of death
17 1031 365,580 Female 2	Male 36	Post tonsillectomy (general anesthesia) 10 days	Septic fever 101-103° F. Marked anapathy	Infiltration entire R.L.L. apex to base. Several fluid levels. 1 largest cavity 2 in diameter	Found pus, an abscess in the right bronchus R.L.L.	Anterior segment R.L.L. and adjacent R.M.L. 5 days	One stage. Ether anesthesia. Thoracotomy approach through 4th rib. Pleural adhesions cut. Large cavity unroofed. Free pleural adhesions cut. Pleural adhesions immediately cut. Opening made with pack. Several adjacent pulmonary loculations unroofed.	Uneventful. Large clean pulmonary defect closed by plastic operation 3 wks after original operation. Discharged 3 wks after and operation, with wound healed.	Uneventful	Well. 2 year follow-up. Symptom-free. Normal x ray
18 1031 376,581 Female 2	Male 36	Indeterminate (poor dental hygiene) 3 wks	High septic fever. Chills, prostration, profuse night sweats. Progressive coughing. Extensive perforation	Large cavity L.U.L. apex to base. Intense inflammatory consolidation surrounding pulmonary infiltration	Found pus, an abscess in the right bronchus L.U.L.	Axillary segment L.U.L. 7 days	One stage. Avertin G.O. in thorax. Posterior approach through 6th rib. Pleural adhesions 1 in cavity unroofed.	Postoperative bronchopneumonia (non putrid) of L.L.L. Discharged 6 wks after operation	Uneventful. Bronchial fistula maintained for 3 1/2 mos	Well. 2 yr follow-up. Symptom-free. Normal x-ray and bronchogram

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, yr, adm, sion No	Sex	Etiology	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
21 S F 1935 386,358	Female	Post tonsil- ectomy (local an- esthesia) 2 wks	Typical	Pneumonic infil- tration meso- portion of base of R L L	1 oral pus, mesial branch of R L L	Mesial segment of R L L, and (mediastino- phrenic aspect) 9 days	One stage Avertin G O an- esthesia. Posterolateral approach through 10th rib No parietal pleural adhe- sions present. Pleural cavity opened and explored. Pleural adhesions present between under surface of lower lobe and diaphragm. Lesion shut off from free pleura by suture and pick- ing. Cavity unroofed.	High fever, toxic psy- chosis. Sterile hydro- pneumothorax. Dis- charged 10½ wks after operation.	Uneventful Bronchial fis- tula maintained for 1 wk after leaving hospital.	Well 1½-year fol- low-up. Symptom- free. X ray normal.
22 G F 1935 386,980	Male	Indetermi- nate (poor dental and oral hy- giene) 1 wk	Unusually pro- fuse sputum 20-30 oz daily. Sputum odorless	Dense shadow lower part of R U L. In mesial part is a 2 in cavity with fluid level	Small amount of focal pus, para-vertebral branch of R U L and apical branch of R L L	Lower segment of R U L, and adjacent R L L 8 days	One stage Avertin G O anes- thesia. Posterior para- vertebral approach through 6th rib. Pleural adhe- sions. Large bullous cavity partially in R U L, and partially in R L L, un- roofed.	Uneventful. Large cleft in lesion in lung closed by plastic operation 7 wks after original operation. Discharged 17 days after second operation with wound healed.	Uneventful	Well 1½ year fol- low-up. X-ray normal. Bron- choscopy negative.
23 M McL 1935 386,583	Female	Post tonsil- ectomy (general anesthesia) 2 wks	Fulminating course, chills, high fever, rapid loss of weight	Cavity with fluid level 1½ in x of R U L. Post- eriorly	Not performed	Apical segment of R U L 1 day	One stage Avertin G O anes- thesia. Posterior para- vertebral approach through 6th rib. Pleural adhe- sions. 3 in cavity un- roofed.	Uneventful except for slight bleeding at first dressings. Discharged 1 wks after operation.	Uneventful Bronchial fis- tula maintained for 10 wks	Well 1½ year fol- low-up. Symptom- free. X ray normal.
24 S S 1915 391770	Male	Unknown 9 days	Fulminating course, high fever, pro- fuse sputum, 40 spms and rapid en- largement of cavity	Infiltration with portion of L U P just above inter- costal fissure. Two irregular cavities present 1½ in	Granulation tissue in L U L from chills. No secretion ("shift off" lesion) 1½	Axillary segment of L U L 1 day	One stage Avertin G O anes- thesia. Axillary approach through 4th rib. Pleural adhesions not present. Pleural cavity opened and ex- plored. Pleural adhesions present at a higher level. Lung sutured to parietes. 4th rib resected. Dense pleural adhesions present at this site. Large multi- locular cavity unroofed.	Uneventful. Discharged 1 wks after operation.	Uneventful Bronchial fis- tula maintained for 1 mos	Well 1½ year fol- low-up. Symptom- free. Normal x ray
25 L A 1915 388,003	Male	Post tooth extraction (local an- esthesia) 3½ wks	Very profuse expectora- tion. Rapid enlargement of cavity. Marked toxicemia	Extensive area of consolidation up- per part of R L L contain- ing a 2 in cavity with fluid level	Not performed	Posterolateral segment of R L L Operated upon on admission	One stage Avertin G O anes- thesia. Posterolateral ap- proach through 8th rib. Pleural adhesions. 3 in cavity unroofed.	Uneventful. Discharged 13 days after operation.	Uneventful Bronchial fis- tula maintained for 5 wks	Well 1½-year fol- low-up. Symptom- free. Normal x ray
26 T McK 1916 388,797	Male	Indetermi- nate (poor dental and oral hy- giene) 16 days	Typical	1 in cavity with fluid level, axillary region. Lung moderate sur- rounding infiltri- tion	Not performed	Posterolateral segment L L L 1 days	One stage Avertin G O an- esthesia. Posterolateral approach through 6th rib. Pleural adhesions. Cavity unroofed.	Uneventful. Discharged 16 days after operation.	Uneventful Bronchial fis- tula maintained for 2 mos	Well 1½-year fol- low-up. Symptom- free. Normal x ray

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Concluded

Name, year, admission No.	Sex, age	Etiology, Duration before admission	Pre operative course, special features	X ray	Bronchoscopy	Location of lesion In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
11 1916 309251 Female 31	Spillover from chronic putrid abscess L.U.L.	10 days	Frequent hemoptyses	Cavity with fluid level axillary portion of L.L.L.	Foul pus, postero-lateral branch L.L.L.	Posterolateral segment of L.L.L. 3½ wks	One stage. Avertin G O anesthesia. Postero-lateral approach through old incision. Pleural adhesions 1.5-in. cavity in lower lobe unroofed	Subsequent drainage of chronic putrid empyema derived from original putrid abscess of lung. Discharged 7½ wks after operation	Uneventful. Bronchial fistula maintained for 10 wks	Well 1 year follow-up. Symptom free
12 1916 102,959 Male 31	Posttuberculous (general anesthesia)	1 mo	Frank hemoptysis	Area of infiltration near vertebra column 7th to 9th ribs posterior side. No fluid level	Not performed	Apical segment R.L.L. 5 days	One stage. Avertin G O anesthesia. Paravertebral approach through 7th and 8th ribs. Bilateral pleural adhesions. Pleura entered and explored. Dense adhesions present more medially. Lung approximated to parietes. 2-in. cavity unroofed	Uneventful. Discharged 1 wks after operation	Uneventful. Bronchial fistula maintained for 5 wks.	Well 1 year follow-up. Symptom free
13 1917 372,531 Female 52	Laceration of esophagus by chicken bone	5 wks	Persistent pain in chest, weakness, fever, foul sputum, and loss of weight	Dense infiltration, mesial half of R.U.L. 1½ in. cavity at level of 4th and 5th ribs posteriorly. Pneumothorax with 33 per cent collapse of rt lung	Foul pus, apical branch of R.U.L.	Abscess of posterior mediastinum with extension into R.U.L. of lung 1 wk	Two stages. 1st stage. G O anesthesia. Paravertebral approach through 1st, 2nd, and 3rd ribs. Inadequate pleural adhesions. Pleura opened and packed locally. Second stage, 9 days later. G O anesthesia. Median sternotomy. Abscess of lung then exposed and unroofed. Both lesions packed	Postoperative toxic psychosis	Uneventful. Bronchial fistula maintained for about 1 wks	1½-year follow-up. Except for pain in operative scar, patient is symptom free. X ray negative
14 1932 351,311 Female 10	Laceration of esophagus by meat bone	11 days	Septic course, toxic psychosis, dyspnea, and rapid pulse. Copious foul sputum	Infiltration mesial portion of R.U.L. apex to 2nd rib anteriorly. With-in infiltrated area a fluid level extending from chest wall to a point beyond the midline	Foul pus, apical branch of R.U.L.	Large abscess of anterior, middle, and posterior mediastinum with extension into R.U.L. of lung. Operated upon admission	One stage. G O anesthesia. Paravertebral approach through 5th and 6th ribs. Large mediastinal abscess entered and evacuated. Abscess of lung exposed. Both lesions packed	Uneventful. Patient discharged 12 weeks after operation	Uneventful. Bronchial fistula maintained for 4 mos	Well 2½-yr follow-up. Symptom free. X ray negative

situated Among these the involvement of 2 or more contacting bronchopulmonary segments was revealed in a few instances. In 2 cases the abscess was shut off from the communicating bronchus, and in these, bronchoscopy confirmed the presumptive diagnosis of a "shut-off" lesion. The single error in localization of the abscess by bronchoscopy led to an operative approach at an incorrect site (Case 10).

The amount of foul pus encountered at bronchoscopic examination ranges from very small amounts to large quantities. The technique whereby the source of foul pus can be identified with precision, even when the bronchial tree on the involved side is more or less completely flooded, can be acquired only by those who are especially interested in, and frequently examine, such cases. Skillful bronchoscopic examination was particularly valuable in the diagnosis of 2 cases (Cases 9 and 22) in which the *sputum was not foul*, for it disclosed not only the presence but also the precise origin of *foul pus*.

Bronchoscopy is *not* indicated in cases of perforated abscess of the lung, because operation usually is imperative and localization of the lesion rarely offers difficulties. It was performed, however, in 1 of our 11 perforated cases, an instance in which the diagnosis of perforation was not made prior to operation.

Concerning the 14 unperforated cases of abscess of the lung in which diagnostic bronchoscopy was not performed, 9 of the patients were considered too ill for bronchoscopy, or were operated upon as emergencies. In 2 instances, an incorrect diagnosis of perforation into the pleura was made. In the 3 remaining cases precise localization of the abscess was simple, and the existence of a foreign body or an endobronchial lesion seemed quite unlikely.

Duration of illness The duration of illness of the cases of perforated abscess now will be discussed. Before doing so we wish to emphasize that we are discussing only cases in which a substantial pulmonary abscess is present, and do not include cases of small "cortical" abscess with perforation. In the latter, the symptoms are essentially those of the complicating pleural infection and not those of pulmonary abscess. Thus, in the majority of our

patients, the expectoration of foul pus and other manifestations of abscess of the lung continued after perforation had occurred. It can be stated at once that the diagnosis of perforation was found at operation to be incorrect in some of the cases, and, conversely, that pleural penetration was not suspected in some instances in which it was found at operation.

Of the 11 perforated cases, 2 had had symptoms of pulmonary abscess for less than 1 week before admission; 2 had been ill for 1 to 2 weeks, 4 had been ill for 2 to 3 weeks; and 3 had been ill for 4 to 5 weeks.

Seven were operated upon as emergencies on admission because the existence of perforation was recognized, 2 were operated upon in the first, and 2 in the second week of observation in the hospital. In 2 of the 11 cases (Cases 37 and 44), perforation occurred undoubtedly during the patient's pre-operative stay in the hospital.

An analysis of the known (or assumed) time of perforation in the 11 cases leads to some interesting conclusions. In 2 cases, perforation occurred in the second week, and in 6 cases in the third week of illness. Two others were known to have had pleural invasion in the third or, at the latest, in the fourth week; and in the last case, perforation *probably* occurred in the fourth week. In other words, perforation into the pleura occurred in the second or third week in most of the cases. A second conclusion to be drawn from our analysis is that the existence of *localized perforation* cannot always be recognized before operation. Finally, perforation can occur during hospital observation as well as before admission.

Of the 34 unperforated cases, the duration of illness before admission to the hospital was: up to 1 week, 2 cases; 1 to 2 weeks, 13 cases; 2 to 3 weeks, 7 cases; 3 to 4 weeks, 9 cases; 4 to 5 weeks, 2 cases; fifth week, 1 case.

The duration of illness during hospital observation before operation varied somewhat, but it will be noted that the great majority of the patients were operated upon in the first week of hospitalization. The figures are as follows: operation on admission, 3 cases; in the first week, 23 cases, in the second week, 6 cases; and in the third and fourth week, 1 case each.

tartar The conclusion reached by him was that abscess of the lung in cases of "uncertain" origin, often was derived from teeth or gums by aspiration. Of our 26 cases of acute abscess in which the etiology was "uncertain," 17 presented gross gingivodental infection. For the reasons advanced in Stern's paper we concur in his view that these cases are of gingivodental origin. In 9 instances the etiology was entirely obscure and such cases are often referred to as of pneumonic origin. No differences in clinical course or in pathological features were discerned in these cases as compared with those of definite etiology. Furthermore on x-ray examination the pulmonary infiltration which preceded cavitation was no more extensive than in cases of known etiology. For these and other reasons referred to elsewhere, we believe that pneumonia is not the etiological factor in acute abscess of the lung of obscure origin.

It would lead too far afield to discuss the varied etiology of the 45 cases in relationship to the question of the aspiratory versus the embolic theory of causation of putrid pulmonary abscess. However an examination of the tabulation of the etiology of these cases indicates that embolism played no rôle with 1 (Case 45), or possibly 2, exceptions (Case 37).

An interesting sidelight on gingivodental infection as a cause of putrid abscess of the lung is offered by the fact that pulmonary abscess of "uncertain" etiology occurred among adults alone. In all of the children in our series, the cause of the pulmonary abscess was obvious. Since severe gingivodental lesions are encountered very rarely among children the importance of the oral status in the etiology of abscess of the lung in adults becomes evident.

Roentgenographic features The characteristic roentgenogram of the chest in cases of acute abscess discloses a single localized cavity in the lung with a well defined fluid level, and a surrounding narrow zone of pulmonary infiltration. However, considerable variation from the typical picture is often seen. Thus, the abscess cavity may be filled completely with pus and detritus, and no fluid level may be visible. In such instances the shadow cast by the filled cavity merges with and is indistinguishable from the surrounding pulmonary

infiltration. As a result, there is a fairly dense shadow like that of pneumonic consolidation. At times small areas of rarefaction may be noted in the midst of this infiltration. In other instances there is a wide, instead of a narrow, surrounding zone of increased density although a well defined cavity with or without a contained fluid level is seen. In such cases we have found that the abscess generally corresponds in size to that of the major portion of the area of "pulmonary infiltration" as noted on the roentgen film.

In only 7 of our 34 cases of non perforated acute abscess of the lung, were the roentgenographic features typical in accordance with the definition contained in the first sentence of the preceding paragraph. In these 7 cases the cavity ranged in diameter from about 2 to 4 inches. In the 27 remaining cases the roentgen findings varied as follows: Extensive pulmonary infiltration without evidence of cavitation, 6 cases, extensive infiltration containing single or multiple areas of rarefaction, 19 cases, and extensive infiltration containing a single cavity 2 to 4 inches in diameter, 2 cases. It is significant, we believe, that these atypical findings were encountered most often in cases in which the clinical course was severe.

The characteristic roentgen film of perforated abscess of the lung is that of limited or widespread empyema or pyopneumothorax; more commonly the latter. Because of the comparatively large size and the density of the pleural effusion the details of the causative pulmonary lesion usually are obscured. However in 5 of our 11 cases the pleural lesion was so situated in relationship to the pulmonary abscess that both could be identified in the roentgen film.

Bronchoscopic examination¹ The extraordinary accuracy of properly conducted diagnostic bronchoscopy is evident from an inspection of our case analyses, with particular reference to the operative findings. Bronchoscopy was performed in 20 of the 34 unperforated cases. In 17 of the 20, bronchoscopic examination located precisely the bronchopulmonary segment or segments in which the abscess was

¹All bronchoscopic examinations are performed by members of the laryngological service of Dr. Rudolph Keamer.

GROUP B—ACUTE PUTRID PERFORATED ABSCESS OF LUNG—Continued

Name, age, admission No.	Sex	Age	History before admission	Pre operative course, special features	X-ray	Bronchoscopy	Location of lesion in hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
10 C.H. 1912 315,222 Female 10		3 wks	Indeterminate (poor oral hygiene)	Typical of putrid abscess of lung with later development of severe pleural infection	Circumscribed area of pneumothorax middle third of right chest. Lung is infiltrated and compressed above this region. Infiltration in R.L.T. with small pleural effusion	Not performed	Perforated abscess of R.L.T. Encapsulated putrid interlobar and parietal pyopneumothorax. Operated upon on admission	<i>One stage</i> Local anesthesia through 3rd rib. Drainage of interlobar and parietal encapsulated pyopneumothorax. Exposure of perforated abscess on upper surface of lower lobe. Pulmonary and pleural lesions picked	Uneventful. Discharged 16 days after operation	Uneventful. Bronchial fistula maintained for about 1 mo	Well 2-yr follow-up. Symptom-free
10 H.L. 1913 376,988 Female 20		3 wks	Postmenstrual (for therapeutic abortion)	Typical of putrid abscess of lung with development of severe pleural infection. Chronic rheumatic carditis. Pulmonary abscess. Mitral stenosis	Dense infiltration of medial portion of R.U.P. and thickening of pleura along interlobar fissure. No abscess cavity visible	Not performed	Perforated abscess of R.L.T. Putrid encapsulated interlobar pyopneumothorax. Operated upon on admission	<i>One stage</i> Local anesthesia. Posterior approach through 7th and 8th ribs. Drainage of interlobar encapsulated pyopneumothorax. Exposure of perforated abscess on upper surface of lower lobe. Pulmonary and pleural lesions picked and operation 2 days after first operation. <i>One stage</i> Local and G-O anesthesia. Mediastinal approach through 8th rib. Drainage putrid pyopneumothorax evacuated	Cessation of cough and expectoration. Continued improvement. X-ray 2 days after operation revealed an encapsulated anterior pyopneumothorax	Uneventful. Bronchial fistula maintained for 5 mos	Well 2½-yr follow-up. Symptom-free. X-ray and bronchogram negative
15 A.R. 1915 382,256 Female 70		10 days	Unknown	Typical of putrid abscess of lung with early development of pleural infection	Generalized enlargement of heart. Pleural effusion—lower third of it chest 2 in cavity with fluid level in lung, situated posteriorly near border of heart	Not performed	Perforated abscess of L.L.T. Putrid encapsulated posterior pyopneumothorax. 3 days	<i>One stage</i> Local anesthesia. Postero-lateral approach through 9th rib. Drainage of posterior encapsulated pyopneumothorax. Unroofing of perforated lung abscess. Pulmonary and pleural lesions picked	Two episodes of coronary thrombosis and several small hemoptyses due to minor pulmonary infarctions	Uneventful. Bronchial fistula maintained for 3 wks	Well 1½-yr follow-up. Symptom-free. X-ray negative
13 C.D. 1915 381,900 Female 15		5 wks	Indeterminate (poor oral hygiene)	Typical of putrid abscess of lung with later development of severe pleural infection. Diabetes mellitus	Large pyopneumothorax rt chest with 50 per cent collapse of lung. Abscess of lung with small fluid level situated posteriorly	Not performed	Perforated abscess of R.L.T. Multiple encapsulated putrid pyopneumothoraces. Operated upon on admission	<i>One stage</i> Avertin, G-O anesthesia. Postero-lateral approach through 8th rib. Drainage of multiple encapsulated localities of putrid pyopneumothorax. Exposed and widely unroofed. Pulmonary and pleural lesions picked	Uneventful. Discharged 7½ weeks after operation	Uneventful. Bronchial fistula maintained for 2 mos	Well 1½ yr follow-up. Symptom-free. X-ray negative

GROUP B-1 CUTL PUTRID PERFORATD ABSCESS OF LUNG

[illegible]

Finally, the figures for the total duration of illness before operation are as follows: up to 1 week, 1 case, to 2 weeks, 4 cases; to 3 weeks, 10 cases; to 4 weeks, 7 cases, to 5 weeks, 7 cases; to 6 weeks, 5 cases

The comparatively short duration of illness before admission in the majority of the cases, together with the necessity of early operation in most instances, are indices of the severity of the illness in the preponderance of patients in this series. Of the small group of patients operated upon toward the end of the 6 week period of total illness, some came to operation because of persistence rather than severity of symptoms. In others, the postponement of operation until the sixth week was due to the incorrect assumption of satisfactory progress.

Pre-operative course In the common or so called "typical" case of acute abscess, the clinical manifestations are mild or moderately severe. Thus, the temperature averages around 100 to 101.5 degrees, and cough is moderate. Expectoration is foul, sputum averages about 4 ounces daily and is bloodstreaked from time to time. The general condition is apt to remain fairly good. Of our 34 unperforated cases, only 11 conformed essentially to this clinical picture. In 4 others the clinical course, although only moderately severe, was complicated by episodes of frank hemoptysis. In the 19 remaining cases the manifestations were severe, the clinical course being classified as fulminating in 4, septic in 10, and toxic in 5. The 4 fulminating cases had spiking temperature ranging from 101 to 105 degrees, severe chills (in 3 of the 4), pulmonary excavation extended rapidly, and the general clinical course was one of rapid deterioration. In the 10 cases characterized as septic, pulmonary excavation was also extensive and progressive, fever was high and irregular, but there were no chills and deterioration was not so rapid. The 5 toxic cases ran fairly high fever; however, the outstanding clinical feature was profound prostration and apathy.

A complete analysis of symptomatology will not be given in this paper. However, because of its diagnostic significance, reference should be made to the variations which occurred in one of the important manifestations of the disease, namely, the sputum. As stated pre-

viously, the sputum in "typical" cases is foul, is slightly bloodstreaked from time to time, and averages about 4 ounces daily. Of the 34 unperforated cases, 19 had typical sputum. The remainder presented the following variations: unusually profuse sputum (20 to 30 ounces per day) in 6, unusually profuse but odorless in 2, foul but very scanty in 1, large hemoptyses on one or more occasions in 6.

The pre-operative course in each of the 11 perforated cases was that of the severely toxic or septic type of putrid pulmonary abscess. There were no mild cases. A discussion of the phenomena which characterize perforation, and of the diagnostic criteria of pleural invasion, will not be presented in this paper. However, a few facts gleaned from an analysis of our cases may be stated. The outstanding clinical feature of perforation into the pleura is not only an ominous change in the condition of the patient, but also the suddenness with which it occurs. The physical signs suggestive of fluid, or of fluid and air in the pleura, are definite aids in the diagnosis and are to be contrasted with the vague physical signs usually present when the abscess is confined to the lung. It is assumed by many that the expectoration of foul sputum ceases when an abscess perforates into the pleura. While this may be true in the case of perforation of a small cortical abscess, it is not the rule in rupture of the comparatively large abscess which is the subject of this paper. Thus, the expectoration of foul pus continued in 8 of our 11 cases.

Indications for operation Early in our experience, operations were performed for acute putrid abscess of the lung solely because of imperative indications. In recent years, however, the indications for operation gradually have been broadened so that at the present time there exist, in our opinion, elective as well as imperative indications.

Operation was imperative, by any criteria, in about one-third of the unperforated cases. Thus, there were 11 cases in which an operative attempt at saving of life appeared urgent, because of a hyperacute, fulminating course with or without chills, or a course characterized by severe toxemia and profound asthenia. In the 11 cases of perforated abscess of the lung, operation was obviously imperative.

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analysis of operative cases of *acute* abscess offers the evidence in a comparatively small series. Additional supportive evidence is offered, however, by the findings in a much larger number of cases of *chronic* abscess. Accordingly, we maintain that overlying pleural adhesions are an inevitable accompaniment of putrid abscess of the lung. Adhesions were found at operation in every case of unperforated acute abscess, regardless of how early in the course of the disease operation was performed. Furthermore, the adhesions were sufficiently firm and widespread to agglutinate the apposed pleural surfaces, and thereby permit safe entry of the abscess in one stage. (Cases 7 and 9 are exceptions for obvious reasons)

However, the operative exposure of adhesions sometimes was not a simple matter, and it is probably because adhesions are not always disclosed at the primary incision of the pleura that many observers have questioned our contention that adhesions always are present. Despite painstaking attempts at precise localization, adequate agglutinating adhesions were not found at the site of initial rib excision in all of our cases. Analyzing the 38 operations, adhesions occupying the entire operative field, to the complete exclusion of the free pleura, were encountered in 27. In 7 others, because of slight errors in localization or in placement of the incision, adequate adhesions were found not directly beneath, but immediately adjacent, to the primary operative exposure. (As stated in our previous communication, the entry of the free pleural cavity, directly adjacent to adhesions, no longer constitutes a bar to the performance of a single stage procedure.) There was one gross error in localization, already referred to, and in this case (Case 10), no adhesions were found at the site of operative approach. The absence of adhesions was recognized, and accordingly the pleura was not opened. Adequate adhesions were encountered at a second operation, when the operative approach was made at the correct site a few days later. Disclosure of adhesions, in or adjacent to site of operative approach, at 34 of 35 operations (31 patients), is the best commentary on the accuracy with which acute abscess of the lung can be localized.

Well developed adhesions also existed in the 3 remaining cases, but were not parietal and therefore could not possibly be present at the site of operative approach. In 1 of these (Case 9), the abscess faced an interlobar fissure. In this instance, the adhesions agglutinated the apposed surfaces of the lobes and sealed the fissure about the abscess. In the last 2, the abscess faced the under surface of the lower lobe. In this region, agglutinating adhesions were situated between the under surface of the lobe and the adjacent surface of the diaphragm. This picture presented itself in our Cases 7 and 21.

In the 11 perforated cases, adhesions lying directly over the abscess were of course destroyed in the process of penetration of the abscess into the pleural cavity. It is interesting to note, however, that some attachment of the lung to the parietes in the region of the abscess still persisted in a number of cases at the time of operation.

Entry of the free pleural cavity. The free pleural cavity was entered inadvertently at only 1 of the 27 operations in which there were *parietal pleural adhesions at the site of operative approach*. In this instance (Case 15), in which a child was operated upon under light general anesthesia, the pleura tore, apparently as the result of the patient's straining, after the abscess had been incised. The free pleural cavity was entered inadvertently shortly after rib excision in 4 cases (Cases 5, 14, 20, and 30) and this was *attributable to faulty technique*. (However, the fact that the pleural cavity could be entered so readily was evidence also that there were no adhesions or only scanty adhesions at the immediate site of the primary operative approach.) The pleural opening at once was enlarged in these cases for purposes of exploration.

The free pleural cavity was entered intentionally in 7 cases. Reference already has been made to 3 of these (Cases 7, 9, and 21), in which no parietal adhesions were present because the abscess faced the interlobar fissure or the diaphragm. In the 4 other cases (Cases 13, 24, 32, and 33), the free pleural cavity was opened in order to search for adhesions which were absent at the immediate site of operative exposure.

There remain 23 cases of unperforated abscess in which the indications for operation were considered "elective." Assuredly, a difference of opinion concerning these cases will exist, the generally held view being that abscess of the lung in the acute stage is a non-operative lesion. Although emphasizing that we do not operate in cases of acute abscess of the lung when the lesion is small and the clinical course satisfactory, we wish to state that our operative indications have been widening as the result of increasing confidence in the outcome of operation when performed with the technique we have developed. In our opinion the elective operative indications to be mentioned are tenable only upon application of the principle of accurate pre-operative localization of the lesion and the use of the type of operative procedures which we advocate. We do not hesitate to express the opinion that high mortality and morbidity as well as incomplete results are almost inevitable if methods generally employed at present time in surgical treatment of abscess of lung are applied to cases of acute abscess.

With due regard to the statements contained in the preceding paragraph, our elective indications for operation are: (1) a septic or severely toxic clinical course (bordering on imperative indication), (2) the absence of a tendency toward spontaneous subsidence, (3) an apparently stationary lesion as noted in successive roentgenograms coupled with a moderately severe clinical course, (4) an increase in size of the lesion accompanied by increasing clinical manifestations, (5) a more or less "shut off" lesion or the development of a more or less 'shut off' state in a previously "open" lesion, (6) a dangerously situated lesion, in the 'cardiac' lobe for example, (7) unusually large lesions, (8) the roentgenographic evidence of pronounced pleural reaction suggesting impending or actual perforation of the abscess.

With increasing experience we have become less and less inclined to defer operation if there is doubt as to the satisfactory progress of a case.

THE OPERATION

An outline of the operative procedures which were employed in our 45 cases will be

found in the appended tabulation. The details of technique of operation have been described elsewhere,¹ and will not be discussed in this paper. However, reference will be made to certain aspects of operation which in our opinion, have a significant bearing on the results.

Whether the choice of *anesthesia* is a factor in the results which have been obtained can not be ascertained from a study of our cases. Thirteen of 34 operations for unperforated abscess were performed under local anesthesia. The remainder were carried out under gas-oxygen anesthesia (rarely with the addition of ether). In recent years avertin, supplemented when necessary by gas-oxygen, has been employed. On the other hand, local anesthesia has been used more often than general in the perforated cases.

The reasons for our advocacy of the *one stage operation* have been fully set forth elsewhere. Of the 38 operations (34 patients) for unperforated abscess, 34 were one stage procedures. In 2 instances (Cases 7 and 9) two stage operations were performed because the abscess situated on the under surface of the lower lobe faced the diaphragm. The 2 remaining patients (Cases 5 and 33) early in our experience were operated upon in 2 stages because the free pleural cavity had been opened by accident adjacent to adhesions at the first stage. (At the present time these 2 cases would probably be operated upon in one stage.) All the perforated cases were operated upon in one stage. Later drainage of secondary loculi was carried out in 3 instances to which reference will be made.

The localization of the site of the abscess by pre-operative studies was the sole guide to the placement of the *thoracic incision*. As has been indicated elsewhere we advocate no 'stand-ard' or 'routine approach'. Thus, of 33 operations (34 patients) for unperforated abscess, an avillary approach was made in 6, anterior thoracic in 2, paravertebral in 16, posterolateral in 10 and anterolateral in 4.

The subject of *adhesions overlying the abscess* appears to be the most debated aspect of presentations on abscess of the lung which we have made at various times and places. This

spite of drainage of the abscess at the second stage, and subsequent drainage of the pleural infection, the patient died. At postmortem examination, the lesions found within the right lung and pleura were sufficient to account for death, but whether a cerebral embolus also existed was not determined because of a limited autopsy. This case represents a surgical death which occurred early in our experience, and which we regard as probably avoidable with present surgical methods.

As to the second fatal case (Case 28), the patient was admitted to the hospital 9 days after incision, without anesthesia, of a peritonsillar abscess. Cough and profuse foul expectoration had been present for several days prior to admission, but the unusual clinical feature was a septic course with irregular, spiking temperature and repeated, severe, shaking chills. On admission, the patient was suffering from profound toxemia and toxic psychosis. Successive x-ray films taken before admission revealed a rapidly enlarging abscess involving much of the right lower lobe. The repeated chills and profoundly septic state led to the additional diagnosis of septic thrombophlebitis of a large branch of the pulmonary vein. This appeared to be the most ominous feature of the case. At operation, on the day after admission, a huge pulmonary abscess was evacuated, unroofed, and packed, in one stage. The operation was without incident. Cough and foul sputum ceased, but septic fever and chills continued, and death occurred on the fourth day after operation. The assumption is warranted that in this instance, death was due to a continuation of sepsis and not to operation.

Secondary operations. In a number of cases, secondary operations, oftentimes minor procedures, were performed for various purposes. In the unperforated group, there were 4 cases in which drainage of additional loculi was performed (Cases 3, 14, 20, and 30), the drainage being established through the existing operative wound in 3 of the 4 cases; a putrid empyema was drained in 1 case (Case 9, the fatal case already referred to); plastic operations for early closure of large cavities were carried out in 3 cases (Cases 15, 22, and 27). It should be noted that the latter were opera-

tions of choice, performed for the purpose of shortening the duration of open wounds.

In the perforated group, additional undrained pleural collections were operated upon in 2 instances (Cases 35 and 40); an additional unperforated abscess of the lung was drained in 1 case (Case 37); and minor revision of an existing surgical wound was performed in order to permit more direct drainage in 1 case (Case 43).

Duration of postoperative hospitalization. There is a rather widely held view that serious complications often follow operation for abscess of the lung, and that the period of postoperative hospitalization is inordinately long. The fact is, as already pointed out, that serious postoperative complications were rare. As a corollary, the postoperative stay in the hospital usually was not unduly prolonged. Of the unperforated cases, more than half left the hospital in the first month after operation and most of the remainder left in the second month. The stay of the perforated cases was longer, in a few instances, because of treatment required for large empyema cavities.

Duration of maintenance of bronchial fistula and open wound. The management of the bronchial fistula, a vital part of postoperative treatment, has been discussed elsewhere.¹ The point to be stressed is that closure of the bronchial fistula, always present after an adequate operation for abscess of the lung, should be under control of the surgeon. The fistula is then permitted to close only after all clinical evidence of anaerobic infection has disappeared, after pulmonary infiltration is no longer visible in the roentgenogram, when expectoration is absent or minimal and, if doubt exists, after bronchoscopy has been performed with negative findings.

It has been asked whether difficulty ever has been encountered in closing the bronchial fistula. Difficulties are encountered occasionally in cases of chronic abscess of the lung when one or more fistulas have been present for a considerable period of time. After operation for acute abscess of the lung, however, the problem is not how to close, but rather how to keep open, a fistula which tends to close prematurely. In the majority of our

It should be especially stressed that the pleural entry, whether planned or accidental, took place early in the course of operation (with the single exception already noted—Case 15). Because of this fact there was but one complicating putrid empyema following an operation for unperforated abscess (Case 9), and thus occurred after the first stage of a deliberately performed two stage operation.

Some features of the pathology at operation The superficial situation of the lesion within the lobe of the lung, a fundamental characteristic of putrid abscess which was pointed out in a former communication,¹ goes hand in hand with the presence of overlying pleural adhesions. In each of the 34 unperforated cases, the abscess was entered after traversing a practically avascular shell of compressed lung which measured about one quarter of an inch in thickness. The superficial situation of the pulmonary lesion in perforated cases is self evident, and probably constitutes the most important reason for the occurrence of early perforation.

One of the arguments which we advanced in favor of operation in the acute stage of putrid abscess of the lung was the tendency of the lesion in many of the more severe cases to assume at a comparatively early date some of the pathological features of chronic abscess. Thus, of our 34 unperforated cases, only 18 (little more than half) presented the solitary, unilocular cavity which is characteristic of the early acute phase. Of the lesions in the 16 remaining cases 8 were distinctly bilocular and 8 were multilocular (not multiple). In each of the 11 perforated cases the lesions were unilocular. This perhaps was to be expected because early evacuation of the abscess into the pleura probably reduced the likelihood of further extension of the lesion within the substance of the lung.

The only additional feature of the pathological findings at operation, to which we shall refer here, is the bronchial fistula. One or more freely blowing fistulas was found opening into the cavity in every case. In a few instances in which the fistula was not apparent at operation, because it was plugged with detritus or blood, it was seen at the first dressings.

Postoperative complications The clinical course of our 45 patients, from the time of operation to the time of discharge from the hospital, can be analyzed briefly. In 28 cases recovery was uneventful. In the 17 remaining (13 unperforated and 4 perforated) the post operative course presented complications of varied nature and severity. For the sake of completeness all are included, although several were of a minor nature, others existed prior to operation, and still others appeared to be independent of the operative procedure.

The complications in the 34 unperforated cases (38 operations) were as follows: toxic psychosis, 2 cases, undrained adjacent abscess, 2 cases, undrained adjacent abscess with toxic psychosis, 1 case, sterile hydro pneumothorax and toxic psychosis, 1 case, mild bronchopneumonia (non putrid), 1 case, spillover putrid lung abscess, 1 case, thrombophlebitis of a branch of the pulmonary vein, 1 case, bleeding from the wound at the first dressings, 2 cases. None of these complications was fatal, and few were serious in the sense that they endangered life. Two deaths occurred after operation. These will be discussed separately.

The 4 complications in the 11 perforated cases were as follows: bland cerebral embolus with spontaneous recovery, 2 cases, coronary thrombosis and pulmonary infarction, 1 case and multiple encapsulated non putrid empyemas, 1 case. There were no deaths in the perforated group.

Discussion of deaths As stated in the preceding section there were 2 deaths in the series both occurring in unperforated cases. In 1 case (Case 9) the patient had a single abscess which lay partially within the right middle and partially within the right lower lobe as the result of extension across the sealed-off interlobar fissure. Because of the unusual location of the lesion adhesions were present only between the middle and lower lobe, and between the lower lobe and the diaphragm, there being no parietal adhesions of the lung to the chest wall. For this reason a two stage operation was undertaken. Between the first and the second stage, the patient developed evidence of pleural infection, toxic psychosis (and cerebral embolism?) In

fulminating in 4, septic in 10, and toxic in 5. It was of the severely toxic or septic variety in all cases of perforated abscess.

The outstanding clinical feature of perforation into the pleura was not only an ominous change in the condition of the patient, but also the suddenness with which it occurred. The presence of physical signs of empyema or pyopneumothorax was a definite aid in the diagnosis of perforation, and contrasted with the indefinite physical signs usually found in unperforated abscess of the lung.

Although operation is not advocated in acute abscess when the lesion is small and the clinical course satisfactory, the authors' operative indications have been widening. As a result, elective as well as imperative operative indications are described. Operation was classified as imperative in all perforated cases because severe and oftentimes spreading infection existed, and spontaneous recovery seemed most unlikely. In 11 unperforated cases, operation was imperative because the course was fulminating and hyperacute, or was characterized by severe toxemia. In the 23 remaining unperforated cases, the indications for operation were elective. The authors' elective indications are (1) septic or severely toxic clinical course (bordering on imperative indication), (2) absence of any tendency toward spontaneous subsidence, (3) apparently stationary lesion (in successive roentgenograms) coupled with a moderately severe clinical course, (4) increase in size of the lesion accompanied by increasing clinical manifestations, (5) more or less "shut off" lesion, or the occurrence of a more or less "shut off" state in a previously "open" lesion; (6) potentially dangerous situation of the lesion, in the cardiac lobe for example, (7) unusually large lesions, (8) roentgenographic evidence of pronounced pleural reaction suggesting impending perforation of the abscess.

With 4 exceptions, all operations were performed in one stage. The one stage operation is advocated by the authors only when the exact localization of the abscess by pre-operative studies has been carried out. The principles of operation consist essentially in the unroofing and the wide packing of the abscess cavity.

Pleural adhesions overlying the abscess invariably were present, regardless of how early in course of the disease operation was done.

In 38 operations (34 patients) for unperforated abscess, adequate adhesions occupying the entire operative field at the initial site of rib excision were encountered 27 times. In 7 others, adhesions were found immediately adjacent to the primary operative exposure. In 1 case, no adhesions were found at the initial operative site because of an error in localization. In the 3 remaining cases adhesions, although well developed, were not situated parietally because of the unusual location of the abscess (interlobar, supradiaphragmatic, etc.).

The free pleural cavity was entered inadvertently during only 1 of the 27 operations in which there were parietal pleural adhesions at the site of operative approach. Of the remaining cases, the free pleura was entered accidentally, shortly after rib excision, in 4 cases. It was opened in 7 cases for purposes of exploration.

In all cases, only a thin avascular shell of lung lay between the most superficial portion of the abscess and the overlying sealed off pleura. In 18 cases, a solitary unilocular cavity, characteristic of the early acute phase, was encountered. In 16, the cavities were already bilocular or multilocular. In each perforated case, the pulmonary lesion was unilocular. Bronchial fistulas were present in all cases.

Recovery was uneventful in 28 cases. In 17, there were complications which, for the most part, were not serious. Bronchial fistulas were permitted to close only after all discernible evidence of infection had disappeared—8 weeks in the majority of cases.

There were two postoperative deaths. One was due to pleuropulmonary suppuration. The second was due to the continuation of a sepsis which existed prior to operation. Of the 43 remaining patients 40 were cured according to the criteria stated in the text: (1) healed wound; (2) freedom from pulmonary symptoms; (3) absence of roentgenographic evidences of pulmonary infiltration. In the 3 remaining cases, the period of follow-up was too short to speak of cure, but all were progressing toward cure when last examined.

cases, fistulas were permitted to close within 8 weeks of operation. Since these fistulas were purposefully maintained by packing or by tube, the wounds closed in all cases soon after drains were discontinued. There were 3 patients in whom fistulas were maintained for long periods—7 months, 1 year, and 2 years, respectively. In the first, the cavity was of unusually large size and was obliterated slowly. The second patient insisted upon wearing his tube for a year because he had had recurrence of manifestations when his fistula was permitted to close shortly (prematurely) after operation. In this case, there remains a cutaneous dimple into which a fine probe can be introduced. Because of an oversight, the bronchial fistula was maintained by a tube for 2 years in the third case. It is of interest to note that the wound closed promptly after the tube was removed.

Bronchial fistulas also were present in all of the perforated cases after operation. Fistulas were maintained for periods up to 5 months, the average being about 7 weeks. The wounds generally were closed within a few weeks of the time of bronchial closure. As in the unperforated cases, the wounds closed completely in all cases.

Results of treatment. In evaluating the results of treatment, our criteria of cure are strict. No patient is considered cured unless pulmonary symptoms have disappeared completely, pulmonary infiltration is absent on roentgenographic examination, and the wound is healed. Bronchoscopy and bronchography, if performed, also must be negative. Cure, according to these criteria, usually occurs early and is lasting. There were 2 deaths to which reference already has been made. Of the 43 remaining patients, 32 were in the unperforated group and 11 in the perforated.

Of the 32 unperforated cases, 20 were followed for periods ranging from 1 to 10 years. Complete cure occurred in 11. (In Case 4, death occurred from carcinoma of the stomach 3 years after operation and the lungs were negative at postmortem examination.) The 3 remaining cases were doing well and apparently progressing toward cure when their follow up was terminated as follows: 1 case, after 4 months, suicide; 1 case, after 3 months, death

following operation for strangulated hernia; 1 case, after 3 months, disappeared from observation. The last was the only instance in which our follow up has been incomplete.

The 11 perforated cases have been followed for periods ranging from 1½ to 7 years. All are cured.

SUMMARY

Forty-five consecutive operative cases of acute putrid abscess of the lung treated in accordance with principles described by the authors in another communication, are analyzed. In 34 cases the abscess was confined to the pulmonary parenchyma. In 11 cases the abscess had perforated into the pleura prior to operation.

A single abscess was present in the great majority of cases. The right lung was involved more than twice as often as the left. These facts, in addition to others stated in the text, tend to support the aspiration theory of causation of pulmonary abscess.

The etiology was definite (tooth extraction, tonsillectomy, etc.) in 19 cases. It was entirely obscure in 9. The 17 remaining patients suffered from gross gingivodental infection which, for reasons stated in the text, was regarded as the source of the pulmonary abscess.

The typical roentgenographic features of acute abscess of the lung were present in the minority of cases. Atypical features were encountered most often in the severe cases.

Diagnostic bronchoscopy located with great accuracy the bronchopulmonary segment or segments in which the abscess was situated.

The duration of illness before hospitalization varied from several days to 5 weeks. The majority of patients entering the hospital in the second to fourth week. The complication of perforation of the abscess into the pleura took place most commonly in the second or third week of illness. The relatively short duration of illness before admission, in the majority of cases, together with the necessity of early operation in most instances, indicated the severity of the disease in the preponderance of patients in this series.

Typical clinical manifestations of acute putrid abscess of the lung occurred in only 11 patients. Hemoptysis was an outstanding feature in 4 cases. The clinical course was

TABLE I

	Non-Pregnant	Normal pregnant 3rd month	At term
Non-protein nitrogen	33	30-31	28
Uric acid	3.5	3.3	3.3
CO ₂ combining power volumes per cent	65	55-60	45
Sugar	75	75	75
Sodium chloride	485	485	485-495

1 to 2 weeks. The patient with vomiting of 7 months, on admission had no acetone in the urine, a hemoglobin of 70 per cent, and remained only 6 days. Occasionally patients vomit intermittently throughout pregnancy without the necessity of entering the hospital. In general, the length of time in which vomiting had persisted before the patient entered the hospital had no definite relation to the severity of her condition nor to the response to treatment. This agrees with recent reports (26).

The average duration of pregnancy on admission was 13.9 weeks and only 63.8 per cent were 3 months and under. This was due to the long duration of vomiting in many cases.

The blood pressure was not materially affected. There was a tendency for the pressure to be slightly lower after treatment, although in numerous cases there was some increase. There was a distinct rise to 146 systolic in 2 cases of low reserve kidney and in 2 cases of late vomiting of pregnancy.

The hemoglobin was definitely increased on admission. In most of the severe cases it was 90 per cent or above (Sahli method used). The average was 87.3 per cent. After treatment there was a drop to an average of 76.5 per cent. The increased hemoglobin was no doubt due to the marked dehydration and concentration of the blood. This appears to be of some diagnostic significance as to the severity of the symptoms but by no means is it always indicative. Some patients with a hemoglobin of 90 to 95 were cured merely by frequent small meals and in 1 patient with an admission hemoglobin of 90 it was necessary to induce abortion. Generally when the hemoglobin was low, it denoted less dehydration and the symptoms were readily amenable to treatment.

The value of blood chemical findings is not fully appreciated. They are often said to be of little use in hyperemesis gravidarum. Yet

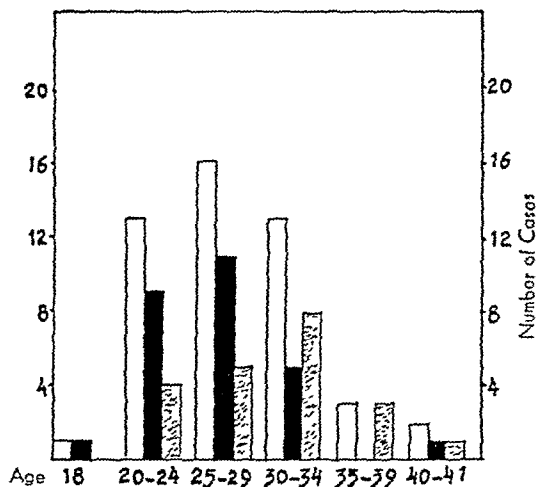


Fig. 1. Chart showing age and parity.

frequently one obtains valuable information and assistance in properly treating individual cases. Many reports are based on a single or admission determination. Most of our patients have repeated or serial determinations which allow a better picture of the progress and response to treatment.

In normal pregnancy there is an alteration in the metabolism and in certain of the blood constituents. The normal values as determined by Stander are shown in Table I. In hyperemesis there is a further change.

Harding (9), Dieckmann and Crossen, Haden and Guffy, Stander and others (5, 15), have found an increased non-protein nitrogen and uric acid in cases of vomiting, especially in the severe cases. By taking serial blood specimens and plotting curves, there is found to be a more or less definite drop following active treatment with fluids (Fig. 2). This is sometimes preceded by a short rise. In cases in which only dietetic measures are used, the drop is not so noticeable. The average non-protein nitrogen (Fig. 3) was 28.6 and the average after the initial drop was 24.6. Some patients in the later months of pregnancy, and possibly before abortion, have a rising curve in spite of active treatment. This is more noticeable in the uric acid curve than in the non-protein nitrogen (Fig. 5).

The uric acid usually follows the non-protein nitrogen (Figs. 2 and 4). Some of the

A STUDY OF HYPEREMESIS GRAVIDARUM WITH SPECIAL REFERENCE TO BLOOD CHEMISTRY

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IT is generally agreed that hyperemesis gravidarum is an exaggerated or pernici-ous form of "morning sickness" or nausea and vomiting of pregnancy. Its etiology is not known and although our methods of treatment have gradually improved we have no way of determining which patients will fail to respond to treatment. A critical study of the usual response to treatment may throw some light on these cases.

Generally the cases are classified as neurotic, reflex, and toxic. Many investigators believe that the neurotic type will respond readily to treatment whereas the toxic type does not. Solomons, as well as most present day writers does not believe in the reflex type and he utilizes the Fouchet test¹ to distinguish the toxic from the neurotic. If the Fouchet test is positive, provided there is no albumin in the urine, the case is considered toxic and if the test is negative, the case is classified as neurotic. Van Wyck states that no satisfactory distinction can be made between the toxic and the neurotic vomiting. Plass considers them all neurotic and states he does not know how to differentiate those individuals who will die. Because so many patients respond to suggestive therapy it is natural to suppose that some or all are neurotic. Stander believes that from a clinical study and chemical findings in the blood and urine as well as from experimental work on animals, all cases of vomiting of pregnancy have a toxic basis. The underlying toxemia may be obscured by a predominating neurosis. Accordingly we classify all cases of hyperemesis gravidarum with the toxemias.

There were 86 patients with hyperemesis gravidarum admitted to the New York Hospital in 12,005 admissions—an incidence of 0.71 as compared to 1.21 of Cruikshank.²

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¹An oxidation test for bilirubin. *Compt. rend. soc. de biol.* 1917, 80: 816.

of Costa, and 0.66 of Peckham. According to Pick, 1 in 1,000 and according to Williams 1 in several hundred pregnant women develop hyperemesis.

In this series were included only those patients who were admitted to the wards during their pregnancy and sufficiently studied as to weight, blood chemistry, and water balance—50 in all. Three of these had two admissions and 1 had four admissions. The cases were not divided as to severity. All cases in which patients required hospitalization were considered severe enough to be included in the study. The various theories as to etiology and treatment will not be considered.

The average age was 27.0 years (Fig. 1). There were a greater number of primiparae but no increase in elderly primiparae. The multiparae averaged 1.48 children. Quigley found no increased nausea and vomiting in elderly primiparae, and Misset found no difference in incidence between primiparae and multiparae but he did find that with nausea and vomiting in the first trimester the incidence of late toxemia increased. Schultze, Rhonhof and others (8) find primiparity a definite factor.

There were only 2 negroes, 1 Porto Rican and 1 Mexican in our series. The average number of colored patients in the entire clinic is only 12.1 per cent (19). In a group from Baltimore (26) hyperemesis was equally divided between black and white. Theobald points out the rarity of toxemias of pregnancy in Siam and other countries in the far East. Holman in reviewing the literature concerning hyperemesis gravidarum among various classes, notes that there is little evidence of this condition among the aborigines or so called uncivilized people.

The period of vomiting before entering the hospital varied from a few days to 7 months. However with severe vomiting it was necessary that the patient enter the hospital within

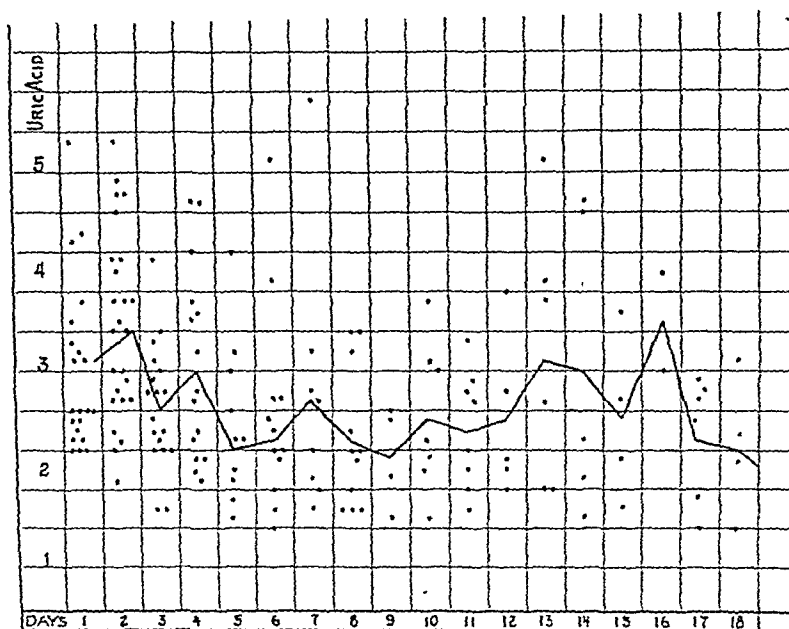


Fig 4. A composite curve of the blood uric acid determinations. This does not depict the early drop as is shown in many of the individual cases.

cases had very little change but, except for an initial small rise, the majority have a distinct fall. It appears that in some cases which will not respond to treatment (Fig. 7) and in certain cases of late vomiting of pregnancy (Fig. 5) the uric acid tends to rise. In the latter cases it may indicate liver damage or even a mild yellow atrophy. Harding and Van Wyck (10), however, suggest that the vomiting of late pregnancy may have its origin in some salt and water disturbance, both sodium bicarbonate and sodium chlorides causing redistribution of water.

Low sodium chloride values are reported in hyperemesis by Stander (40), Harding (9), Haden and Guffy, and Dieckmann and Crossen. In the present series the average sodium chloride on admission was 489 which is essentially normal (Fig 8). There was some tendency to an increase but the change was not great. One case had an extremely low sodium chloride, 365. One had 427 and another 435. Peckham reports an average of 480.9 and 2 patients with less than 400. Haden and Guffy report a case with blood chlorides of 300 and Harding and Van Wyck (12) report a case with blood chlorides of 290, both responding to sodium

chloride therapy. This in itself reveals the value of blood chemical studies in the treatment of individual patients.

The blood sugar (Fig. 9) was fairly constant and apparently agrees with that of most investigators who find a normal or slightly lowered blood sugar (4, 6, 37). Peckham finds

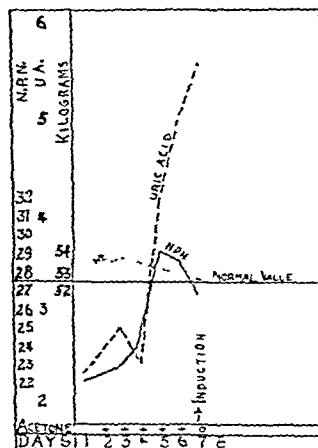


Fig 5 Shows rising non-protein nitrogen and uric acid in late vomiting of pregnancy despite active treatment. Labor was medically induced 2 weeks before term. Case No. 42822

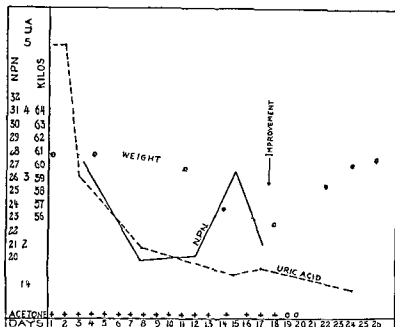


Fig 2 Showing the usual early drop in non protein nitrogen and uric acid. Note the disappearance of acetone in the urine and the rise in weight with improvement. Case No 68307

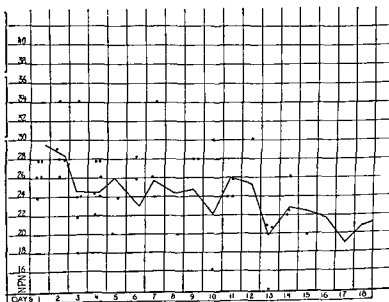


Fig 3 A composite curve of the non protein nitrogen. The early drop is not as conspicuous as is found in many of the individual cases

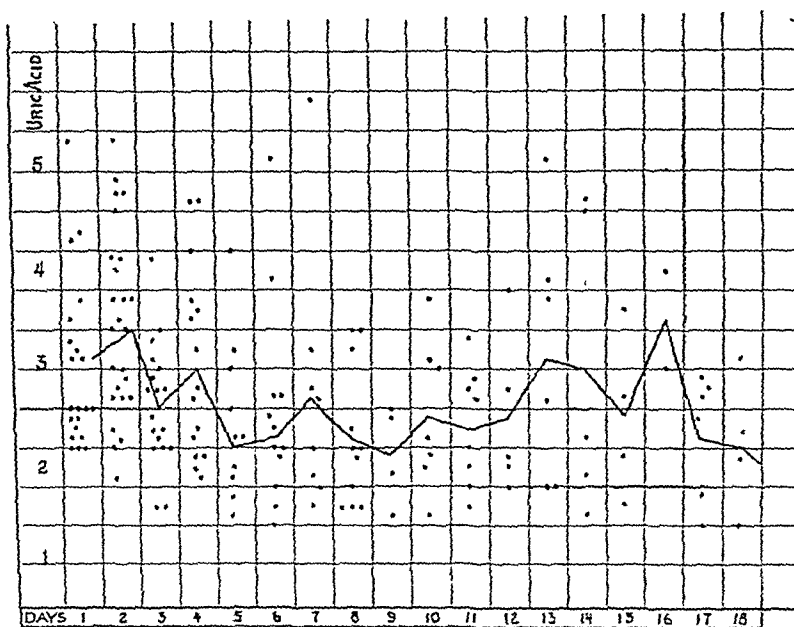


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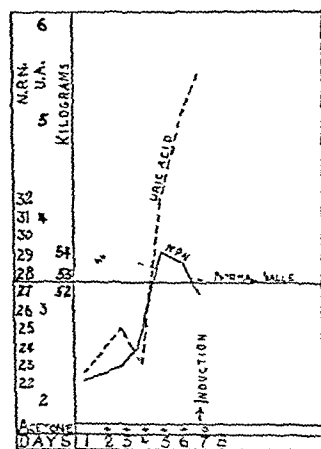


Fig. 5. Shows rising non-protein nitrogen and uric acid in late vomiting of pregnancy despite active treatment. Labor was medically induced 2 weeks before term. Case No. 42822.

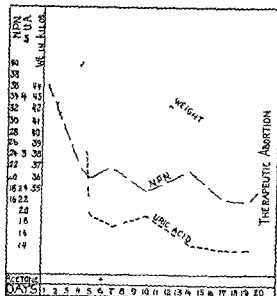


Fig 6 Although the non protein nitrogen and uric acid respond well to treatment showing early drop the patient did not respond clinically and therapeutic abortion was done. However as will be noted the acetemuria was not controlled. Case No 123862

a normal sugar in the mild cases but an increased sugar in the severe cases. Titus found a low sugar and believes carbohydrate deficiency to be the chief underlying factor in pregnancy toxemia. However, a markedly perverted carbohydrate metabolism is well recognized (37) and glucose is generally given because it spares protein and fortifies the liver.

The carbon dioxide curves are very interesting and show wide fluctuations (Fig 10). That the acid base equilibrium is not very stable in normal pregnancy is shown by MacNider who found that in normal pregnant animals there is a definite tendency for the acid base equilibrium of the blood to become disturbed and concludes, from a large series of experiments, that, associated with gestation, there is a definite tendency toward failure to maintain a normal acid base equilibrium. In normal pregnancy there is a reduced alkali reserve (42), as shown by lowered alveolar carbon dioxide tension (13) and a decreased carbon dioxide of the serum (18, 22, 32, 39). Oard and Peters revealed that this lowered alkali reserve was due to the decrease in the fixed base and not to an increase of acids. This was cor-

roborated by Stander (42) who found the hydrogen ion concentration within normal limits but due to the decreased serum bicarbonate there was a "compensated alkali or carbon dioxide deficit" rather than a true acidosis. Voza showed that the decreased alkali reserve was more marked during the first stage of pregnancy and that 300 cubic centimeters of 10 per cent glucose or 10 units of insulin did not change it.

Peckham found a marked variation in the carbon dioxide combining power of the blood in vomiting of pregnancy. Our average carbon dioxide combining power was 45.3 volumes per cent and varied between limits of 27.7 and 64.5. The wide fluctuations may be due to the unstable acid base equilibrium and two opposing factors, one being the starvation acidosis and the other, due to loss of hydrochloric acid and electrolytes in the vomitus, producing an alkalosis. It has also been suggested that the rapidity of change may be of greater significance than the absolute level of the carbon dioxide combining power, as occurs with blood sugar changes in reference to hypoglycemic convulsions (20, 23). Frequent carbon dioxide determinations are therefore, very necessary.

The serum proteins were not determined. Van Wyck considers them of prognostic significance. A high protein determination, with few exceptions, he thinks is a good prognostic sign. Low protein and dehydration signifies a long duration of symptoms with destruction of protein and serious prognosis.

The weight curve appears to be of definite value. Few clinics weigh the patients after admission to the hospital. Yet this is probably more important than the pulse rate in these patients. It is difficult to determine how much weight the patient has lost when she enters the hospital as the figure given by her is often unreliable unless she has been carefully observed. In this series it was given as from 10 to 30 pounds. Peckham reports 6 patients with a loss of weight over 30 pounds, but the loss of weight on admission apparently had no relation to the response to treatment.

Our patients are now weighed every day or on alternate days. The scale is wheeled to the bedside. If the patient is very ill she can be

Fig 7 There is a gradual increase in non-protein nitrogen and uric acid. Note the absence of initial drop, and continued loss of weight. Therapeutic abortion was necessary. Case No 93434

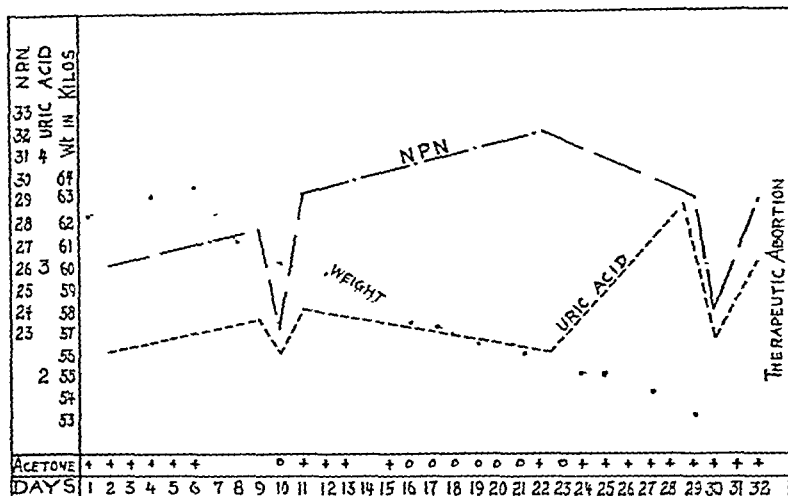


Fig 8 Sodium chloride. The heavy dotted lines are curves of cases requiring therapeutic abortion

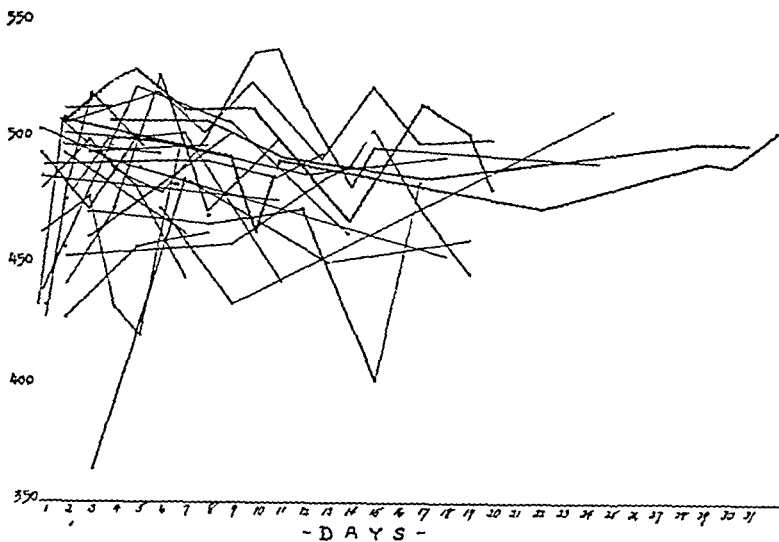
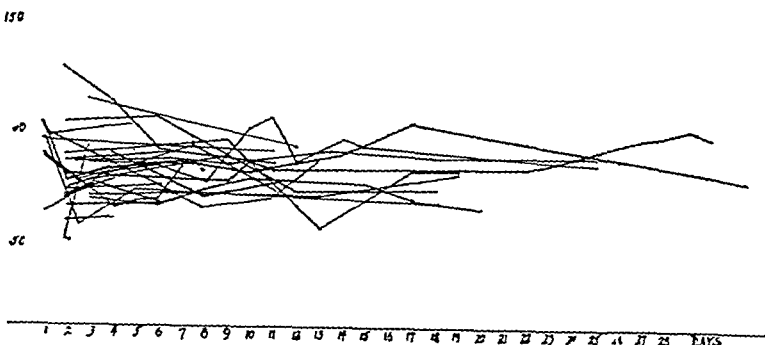


Fig 9 Blood sugar



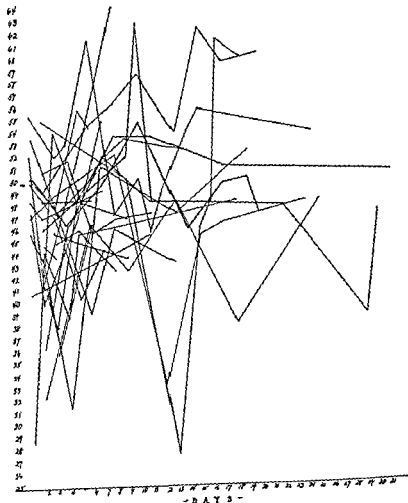


Fig 10 Carbon dioxide combining power

lifted onto the stretcher scale and weighed with little or no disturbance. On admission the patient is already dehydrated, has lost considerable weight, and the subsequent loss is usually important. Figure 11 reveals the weight curves of 17 patients. The average curve generally has an initial rise due to the intravenous fluids administered. It then gradually subsides and with improvement of the patient it begins to rise. In 3 cases in which therapeutic abortion was necessary, the weight curve continued to drop (Figs 6, 7, 11). One patient lost weight rapidly but as the acetonuria cleared up after hypodermoclysis,

and as the blood chemical findings indicated that the patient was reacting favorably, we were not alarmed.

A conspicuous and almost constant finding on admission to the hospital is acetonuria (Table II). This was present in 40 cases and absent in 5 cases. In the latter cases the condition was comparatively mild and required no intravenous therapy. Two patients showed no acetone on admission but did show a trace shortly thereafter. These two patients were each given intravenous injections of glucose. Small amounts of glucose given to starving animals will cause the appearance of a great

TABLE II — ACETONURIA

	Cases
In urine on admission	40
Not present on admission	5
Determination not done on patient	2
Determination not stated	1
Negative on admission but present after intravenous glucose	2
	<hr/> 50

number of acetone bodies in the urine (38). Ketosis as it affects the human organism, however, is not entirely the same as in other species; rats and other animals are very resistant to the development of ketosis (16).

A diet poor in carbohydrates leads to the excretion of acetone bodies in normal pregnant women whereas on an identical diet the non-pregnant women will show no acetone (29, 30). Schmidt and Wingen noted that the large carbohydrate requirement of pregnancy is met by conversion of fat to glycogen and that acid by-products are likely to appear. In hyperemesis, as in starvation, the protein is spared to the very last while the fat is being burned. The fat content of the blood increases and acetone bodies appear in the urine. The acid bodies of the blood are increased in the vomiting of pregnancy according to various observers. Runge and Juhl observed increased amino acids, Loeser reports increased lactic acid, and Bokelmann and Bock found an increase in "acetone bodies."

That the acetone in the urine is not the immediate cause of the vomiting has been clearly shown by Harding (10) who placed pregnant patients on a high fat diet, and found that acetone appeared in the urine, but that none of the patients developed vomiting. There is a close association, however. Thalheimer, Waters, and others observed that the vomiting ceased with the absence of ketonuria. This usually takes place but often the acetonuria persists for a few days after the vomiting has ceased or the vomiting persists with negative acetone findings. However, in the latter condition, the acetone usually reappears within a short time if the vomiting continues.

From a consideration of the facts stated, the value of blood chemistry in hyperemesis gravidarum is at once evident. An extremely low chloride, sugar, or carbon dioxide value can be readily corrected. Mistakes of com-

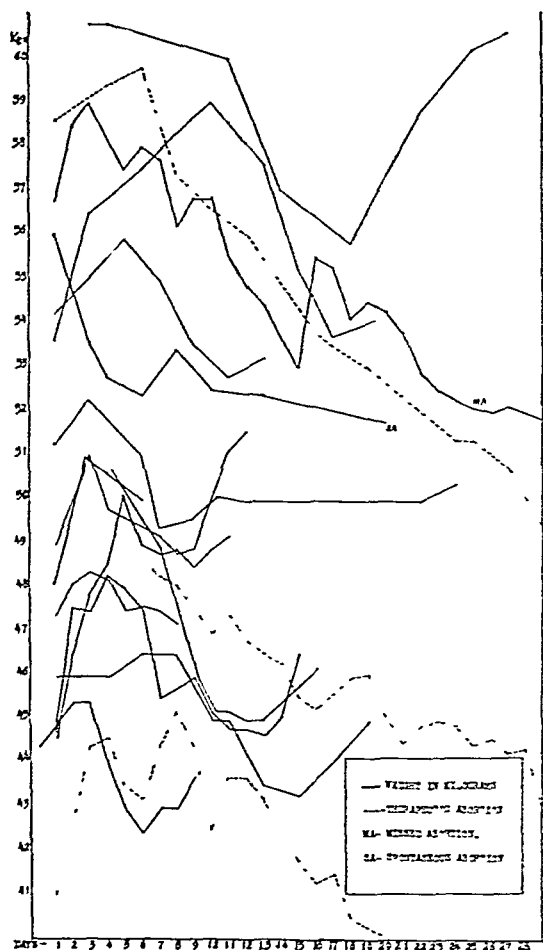


Fig. 11. Weight curves

mission, as exemplified by the following report, can be obviated. Titus relates a case, in which a patient with almost continuous vomiting, acidosis, and dehydration was admitted to the hospital. A blood specimen was taken before the intravenous injection of glucose and it revealed a blood sugar of 230.

One cannot determine the prognosis by any one procedure or finding. It is necessary to take into account various factors. Often the prognosis is facilitated by observing the response to treatment. The objective factors in this study which are somewhat indicative of this response are the curves of the non-protein nitrogen and uric acid, the weight curve, and acetonuria.

It would seem that in the proper treatment of these patients, blood chemical studies are essential. The acidosis must be controlled and by the proper evaluation of the blood findings and weight curve, one can better arrive at a decision as to whether or not interruption of pregnancy is indicated. We consider retinal hemorrhages (40, 45) as absolute indications for interruption of pregnancy. The presence of jaundice is a further indication of the severity of the disease.

SUMMARY AND CONCLUSIONS

1 We classify all cases of hyperemesis gravidarum as toxemia.

2 The incidence in the woman's clinic of the New York Hospital is 0.71 per cent.

3 The average age in this series is 27.9 years and there is an increase in incidence in primiparæ but no apparent increase in elderly primiparæ.

4 Hyperemesis gravidarum is relatively infrequent in negroes.

5 The length of time in which vomiting persists, the duration of the pregnancy, the pulse rate, and the blood pressure have no definite relation to severity of the condition.

6 A high hemoglobin appears to be of some diagnostic significance and as a rule denotes marked dehydration.

7 The non-protein nitrogen content and the uric acid content may be increased but show a sharp drop after treatment with intravenous fluids. In some cases of late vomiting of pregnancy and in some patients who do not respond to treatment the non-protein nitrogen content and the uric acid content tend to rise.

8 Blood chlorides and sugar values are usually within the normal limits. A few patients show extremely low values but respond to therapy.

9 There is a marked fluctuation in the carbon dioxide combining power of the blood with great tendency to acidosis.

10 Acetonuria is a conspicuous finding and although not the immediate cause of vomiting, control by proper therapy is important.

11 The value of blood chemical studies in the rational treatment of hyperemesis gravidarum is at once evident.

12 Prognosis is dependent upon the following: the hemoglobin values, the weight curve, the presence or absence of acetonuria, the blood chemistry determinations, and the effect treatment has on these factors.

13 Among the indications for interruption of pregnancy are continued loss of weight with rising non-protein nitrogen and uric acid, retinal hemorrhages and marked jaundice.

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THE OBSTETRICAL SHOULDER TRAUMA

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THE term, "birth palsy" signifies all clinical manifestations which may be observed after trauma to the shoulder during delivery. The term is misleading. The sequelae of shoulder trauma show that in the majority of cases the lesion does not involve the nerve trunks of the brachial plexus. The clinical material of the Istituto Rizzoli permits, according to Putti, the following classification of cases of "birth palsy."

Obstetrical trauma of shoulder joint	{ Simple distortion
	{ Complicated epiphyseal separation of upper end of humerus
	{ Fracture of clavicle
Obstetrical paralysis	{ Upper type
	{ Lower type
	{ Total type
	{ Associated atypical forms

There are also mixed forms which involve ment of nerve roots and of the joint ends. These cases show the most complicated clinical picture.

This classification is of great practical value because, as stated by Putti, the clinical picture of the obstetrical trauma should not be confounded with obstetrical paralysis.

From 1899 to June, 1935, 199 cases of obstetrical shoulder lesions were observed in the Istituto Rizzoli; 171 cases were hospitalized, 128 were seen and given ambulatory treatment.

Statistically, it is demonstrable that the obstetrical shoulder lesions are more frequent in males (55.27 per cent) than in females (44.72 per cent), more often unilateral (93.46 per cent) than bilateral (6.53 per cent). The right side was involved in 62.81 per cent, the left in 30.65 per cent.

During delivery in the more common type of head presentation the right shoulder is pressed more often and longer against the pubic arch, which explains the more frequent involvement of the right side. In breech presentations, the obstetrical lesion is bilateral in the majority of cases (6 cases).

From The Istituto Ortopedico Rizzoli. Prof. Dr. Vittorio Putti, director.

In none of the cases was heredity a factor. Obstetrical shoulder lesions are acquired during delivery.

In the 199 cases, there were 62 cases of obstetrical joint lesions, 22 cases of obstetrical paralysis, 14 cases were mixed forms. (The 101 ambulatory cases could not be classified). This shows that joint lesions occur more frequently than the other forms and that the general opinion that obstetrical shoulder lesions are of nervous origin is not correct.

In this article, it is our purpose to discuss only the complicated obstetrical joint trauma, the lesion most frequently encountered in our series (53 cases). Although most of these cases came to clinical observation relatively late after injury, it was possible to determine that the primary lesion in all cases was an epiphyseal separation at the upper end of the humerus.

Our clinical and radiographic knowledge of epiphyseolysis in the newborn is not very extensive. Inasmuch as the clinical symptoms after epiphyseolysis are essentially the same as after obstetrical paralysis (functional disability and internal rotation contracture of the arm), these two essentially different lesions have been considered as the same. Poh has contributed valuable experimental, anatomical, and clinical data concerning the epiphyseal separation of the upper end of the humerus. We are here mainly interested in the roentgenological findings of the obstetrical shoulder trauma. On this basis, it will be possible to explain the after effects of the complicated obstetrical shoulder trauma.

The x-ray picture taken in an early stage of the shoulder lesion is entirely negative. There are no changes in the upper end of the humerus. The first positive signs appear with the formation of periosteal callus in the form of a cloudy shadow around the upper end of the humerus (Fig. 1). Toward the third month, however, when the bony nucleus appears in the head of the humerus, a more precise statement can be made as to whether there was a



Fig 1 Sixteen day old boy Typical picture of bilateral periosteal epiphyseolysis with periosteal callus formation around metaphyses Breech presentation, delivered by manual extraction

partial or complete epiphyseolysis with or without displacement of the upper end of the humerus (Fig 2). Before the third month, some cases may show mild structural changes in the metaphysis, suggestive signs of traumatic lesion.

The exact diagnosis of a traumatic shoulder lesion is of great value. If there is no displacement of the epiphysis, almost complete cure can be expected without any involvement of the joint. If there is displacement, the clinical and roentgenological syndrome of obstetrical shoulder trauma will develop. Cases without displacement of the upper fragment show 4 to 5 months after birth some circumscribed enlargement of the diaphysis with periosteal callus undergoing resorption. These structural changes gradually disappear entirely and the shoulder joint remains intact. However, if there has been displacement of the cartilaginous epiphysis, the shoulder joint will show involvement. We believe that these cases do not represent a simple epiphyseolysis, i e, a separation along the epiphyseal line, but a fracture through the cartilaginous epiphysis, which means that the separation is above the

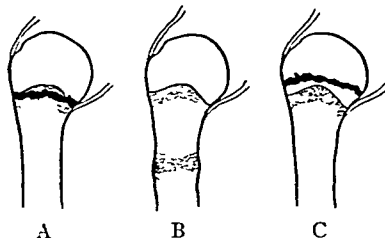


Fig 2 A, Fracture through epiphyseal plate B, Fracture line becomes displaced distally by the physiological bone growth C, Fracture through epiphyseal cartilage. The fracture line is above the epiphyseal plate and there is no displacement by bone growth.

epiphyseal line. This assumption explains why so many cases are without periosteal callus formation during the first few weeks after delivery and why so rarely signs of hematoma or swelling of the shoulder are encountered.

SYMPTOMATOLOGY OF THE SEQUELÆ OF THE COMPLICATED SHOULDER TRAUMA (FIGS 3-7)

On *inspection* (Figs 3-7), one notices internal rotation of the upper arm and consequently pronation of the forearm. The arm is frequently kept slightly abducted with flexion in the elbow. If the abduction in the shoulder is not noticeable on inspection, it is due to the position of the scapula which is tilted with its greater diameter, the lower corner being approximated to the spine, the upper corner prominent under the upper margin of the trapezius muscle. On abduction of the arm, the symmetry of both shoulder blades can be restored.

This symptom is due to joint contracture, to shrinkage of the capsuloligamentous ap-

Fig 3 Eight year old boy Manual delivery with traction on left arm Hypotrophy of deltoid muscle, abduction and internal rotation contracture of left shoulder, + Loss of normal shoulder relief

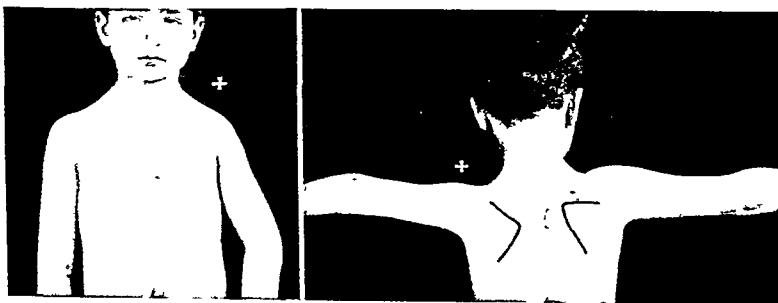


Fig 3



Fig 4 Six year old girl Manual delivery On external rotation of left arm the upper corner of the scapula appears below the margin of the trapezius. (Scapula sign of Putti)

paratus There are other signs of this contraction Putti noticed that on external rotation of both arms, the upper corner of the scapula appears at the upper margin of the trapezius (scapular sign of Putti, Figs 4, 6) This sign is due to joint rigidity by which all the arm motion is transmitted to the scapula If the arm is abducted, the scapula rotates along its longitudinal axis and becomes elevated (Fig 3)

If the arms are crossed in front by forced adduction, the scapula lies almost in a sagittal plane, the vertebral margin being sharply prominent under the skin (Fig 5)



Fig 5 Four year old boy Forceps delivery Atrophy of right shoulder muscles Internal rotation of arm Shortening of 1 centimeter By adducting the arms (adduction on right side diminished) the vertebral margin of the scapula is brought almost into a sagittal plane

The normal external configuration of the shoulder is lost The arm hangs lower than its mate, the roundness of the shoulder relief has disappeared and sometimes the coracoid process is clearly visible under the skin The loss of shoulder roundness is especially visible when the patient is looked at from above (Putti)



Fig 6



Fig 7

Fig 6 Eight year old boy Forceps delivery No external rotation on right Putti's scapula sign well visible Loss of normal shoulder relief Coracoid process strongly prominent

Fig 7 Same case as in Figure 6 Scapula high and hypoplastic Abduction and internal rotation of right arm which is considerably shorter Beginning left convex scoliosis

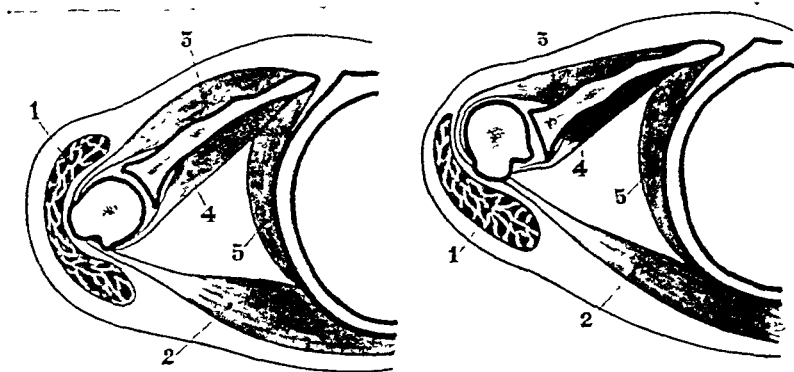


Fig 8 Horizontal section through shoulder region (schematic) to illustrate the anatomic conditions of the different muscle groups in the sequelæ of obstetrical shoulder trauma. A, left. Normal conditions; B, obstetrical trauma. 1, Deltoid muscle, 2, pectoralis major, 3, infraspinatus, 4, subscapularis, 5, serratus magnus. The obstetrical trauma with the resulting retroversion of epiphysis and the internal rotation of the arm leads to atrophy of the deltoid, 1, pectoralis major, 2, subscapularis, 4, contracted because their points of origin and insertion are approximated. The infraspinatus muscle, 3, is lengthened and under constant tension.

The shoulder muscles are fairly well preserved. They are hypotrophic, but there is not as much atrophy as is observed in nerve lesions. There is almost always present a shortening of the humerus (2 to 3 cm.), quite frequently there is also shortening of the forearm and hypoplasia of the hand. The scapula is always hypoplastic and its vertebral margin is at considerable distance from the thorax; the scapula is much higher, its inferior corner about 2 to 3 ribs higher than the normal side (Fig. 7).

On *palpation*, the head of the humerus is found smaller and displaced backward. It is not in front below the coracoid process but behind the acromial process in retroversion. It is impossible, even by passive motion, to center the head of the humerus into the glenoid fossa. Sometimes, however, on abduction and external rotation, it seems as though the head would slip into place with a little jump when the upper epiphysis passes over the posterior border of the glenoid. In almost all cases, from the third to fourth year of life, a definite step can be noticed in the posterior shoulder region, due to the inclination of the neck of the humerus, which is accentuated in these cases (Fig. 7).

Active motion shows: (1) abolition of external rotation, due to shrinkage of capsule

and shortness of internal rotators; (2) limitation of abduction by about 50 per cent, partially compensated for by motion of the scapula; (3) limitation of flexion and extension. There is considerable joint rigidity which can also be noticed on passive motion (Fig. 8).

The *electric examination* does not reveal nerve lesions, nor muscle degeneration; quite frequently, however, the shoulder muscles are less responsive to faradic and galvanic currents, the result of inactivity. There is no disturbance of sensation.

Roentgen anatomy. The sequelæ of complicated obstetrical shoulder trauma have a typical x-ray appearance which permits early differentiation from pure obstetrical nerve lesions. The bony nucleus of the head of the humerus may appear later on the affected side. Typical cases show it displaced laterally over the outer half of the metaphysis; quite often it is slightly elevated from the inner side and it is always hypoplastic.

We tried to find out whether the lateral displacement of the epiphysis was only apparent and entirely due to the internal rotation. Figure 9 shows roentgenograms of a normal humerus in different projections. B is a view taken in moderate internal rotation. There is hardly any lateral displacement of the epiphysis. C is taken in forced internal rotation

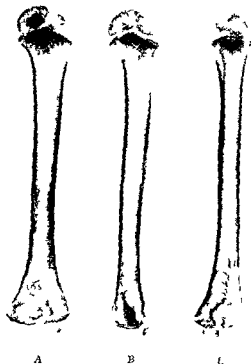


Fig 9 Normal left humerus of 3 year old boy. A Roentgenogram in neutral rotation B In internal rotation C In total internal rotation The epiphyseal bony nucleus does not rub any more over the inner half of the metaphysis but is displaced laterally overlapping the shadow of the greater tuberosity the metaphysis has lost the normal roof shape and appears narrowed

and reveals some lateral displacement. However, such a degree of internal rotation is never observed after obstetrical trauma and still the lateral displacement of the epiphysis is by far more marked in these cases. We deal therefore with a real displacement of the epiphysis which becomes more marked by internal rotation (Vannini).

If one takes roentgenograms of the shoulder joint in axial (craniocaudal) direction, one obtains pictures of great value (Fig 10). Normal pictures reveal the epiphysis opposite the glenoid fossa and overlapped by the shadow of the acromion. In cases of obstetrical shoulder trauma the epiphysis is always displaced clearly backward from the glenoid cavity and behind the shadow of the acromion. The glenoid is not always visible because the arm can not be brought into full abduction.

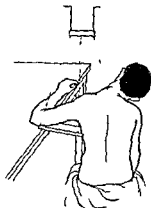


Fig 10 Schema of axial projection of shoulder joint.

The axial view of the shoulder should be taken in every case of obstetrical shoulder trauma because it shows whether there exists a displacement of the epiphysis with increased angle of declination.

These roentgen findings are typical and can be observed up to about 3 years of age. When the bony nuclei of the tuberosities of the humerus begin to appear, their shadows overlap the epiphyseal nucleus due to the inward rotation of the arm. The backward displacement of the epiphysis is less marked at the age from 8 to 10 and decreases even more as the years go by. However, it never disappears entirely. Simultaneously, the anteroposterior view reveals that the lateral displacement of the epiphysis becomes less, the bony nucleus—due to its hypoplasia and internal rotation—appears deformed, sometimes pear shaped, sometimes triangular or boat shaped.

We are unable to say how the epiphysis gets recentered; it is probably a progressive adaptation by growth and function.

There are also roentgenological signs of involvement of the other joint components. The hypoplasia of the epiphysis makes it appear as though there was a wide separation between epiphysis on one side and glenoid and acromion on the other. Quite frequently, the nuclei of both tuberosities appear later than on the other normal side.

The upper metaphysis of the humerus is smaller and flat instead of cone shaped. An irregular condensation along the epiphyseal line is to be observed in the first year of life.



Fig 11 Boy, $2\frac{1}{2}$ years of age Breech presentation Manual extraction. Marked lateral displacement of the hypoplastic epiphysis. The bony nucleus of the greater tuberosity still absent (present on normal right side). Metaphysis narrowed, sclerotic, with loss of the normal roof-shape. Wide space between glenoid and epiphysis.

Scapula high with atrophy of glenoid. Axial view. Right normal side: 1, Coracoid; 2, acromion; 3, glenoid; 4, acromial end of clavicle; 5, epiphysis of humerus; 6, greater tuberosity. The humeral epiphysis is below the acromion. Strong retroposition of epiphysis: 1, coracoid; 2, acromion; 3, acromial end of clavicle; 4, epiphysis of humerus.



Fig 12 Four year old boy. Delivery by manual traction on right arm. Hypoplasia of epiphysis of humerus. Lateral displacement of bony nuclei of greater tuberosity

and head of humerus. Scapula high, hypoplastic, and anteverted. Axial view shows retroversion of epiphysis: 1, Coracoid; 2, acromion; 3, epiphysis; 4, greater tuberosity.

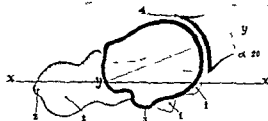


Fig 13 Angle of declination of neck of humerus Upper and lower end of humerus projected in horizontal plane 1 Trochlea humeri 2 epitrochlea 3 capitulum humeri 4 epicondylus lateralis 5 upper end of humerus 6 glenoid cavity 7 y-y axis of head and neck 8 x-x transverse axis of lower end of humerus The angle between x-x and y-y is the angle of rotation or declination α It is about 20 degrees and opens inward and backward

This irregularity is hard to explain, most likely it indicates a traumatic lesion

The glenoid, up to 3 or 4 years of age, does not differ appreciably in shape and development from the normal. Changes appear around the fourth year of life. First only a slight hypoplasia can be noticed which gradually increases to a real aplasia. This is especially true for the lower half which appears to be cut away. The joint margin is sometimes sclerotic. There is no neck of the scapula. Rather frequently in more severe, inveterate cases (15 to 16 years) the lateral margin of the scapula runs directly into the glenoid. The

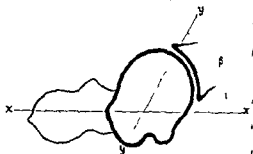


Fig 14 Figure 14 15 and 16 show the changes in the configuration of the humerus after obstetrical shoulder lesion. The angle of declination is increased by backward displacement of the axis y-y. The transverse axis of the lower end of the humerus x-x remains in the frontal plane. The contact surfaces between head and glenoid change

aplasia of the glenoid corresponds exactly to that of the acetabulum in cases of congenital dislocation of the hip joint

All these signs are associated with a general hypoplasia of the scapula, only the coracoid process and acromion appear larger, which fact is due to the oblique view in which the roentgenogram is taken (inclination of the scapula)

The clavicle very often shows signs of a fracture in the middle third with callus formation in the first months of life, later with

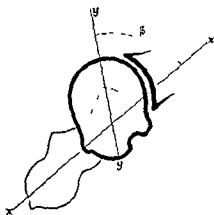


Fig 15 If the increase of the angle of declination B is associated with an internal rotation of the transverse axis of the lower end of the humerus x-x the head has contact with the scapula only with its anterolateral pole. The epiphysis is turned backward and the greater tuberosity is in front. Such are the findings at surgical intervention

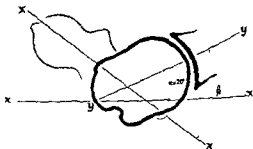


Fig 16 The epiphysis of the humerus regains normal contact with the glenoid after the capsule has been cut and the extremity turned outward. The transverse axis of the lower end of the humerus x-x shows marked external rotation because there is no change in the angle of declination, B. To re-establish normal anatomic conditions it is necessary to break the continuity of the humerus between epiphysis and diaphysis and to turn the lower fragment inward thus decreasing the pathologic angle B to the normal angle α

irregular sclerosis in the middle third. It is hypoplastic, shorter and, in some cases, its S-curve is accentuated. Due to the elevation of the scapula it may appear turned forward

SURGICAL ANATOMY

Muscles The contraction of the subscapularis muscle (frequently also of a small part of the pectoralis major) commonly limits external rotation. It is almost always present in cases over 6 years of age, but may be absent in younger individuals. There may also be a shortening of the coracobrachialis and of the short head of the biceps which explains the slight flexion contracture of the elbow (Fig. 8).

Capsule If there is no contracture of pectoralis and subscapularis muscles, the obstacle to external rotation is represented by the thickened, contracted joint capsule. Even after myotomy of the pectoralis and subscapularis muscles, external rotation is not complete. To obtain full external rotation, it is necessary to cut the joint capsule. The main reason for the internal rotation of the arm is the shrinkage of the anterior portion of the joint capsule. In the same way, the abduction contracture is principally due to contracture of the upper portion of the joint capsule and of the scapulohumeral ligament. There are also small adhesive bands at the joint margins in the upper and front parts of the shoulder joint.

Head of humerus. After incision of the joint capsule, one finds that the joint surface of the humerus is not in contact with the joint surface of the glenoid, neither with acromion and clavicle, but that it is displaced backward, retroverted and partially dislocated. In the typical position of internal rotation, the head of the humerus is in contact with the glenoid only with its anterolateral pole. If one brings the arm in external rotation and extension, a definite sound of reduction can be heard, and the head is brought into contact with the glenoid cavity and fills the subacromial space. On further forced external rotation, the head of the humerus slips out of the capsule, resulting in an infracoracoid dislocation of the shoulder and presenting itself for full inspection. The epiphysis is much smaller, deformed, either pear-shaped or gland-shaped. Some

cases show circumscribed small areas of atrophy of the joint cartilage. The epiphysis is retroverted, displaced also medially along the metaphysis, and the angle of inclination is increased.

The *glenoid* shows the main changes in the lower half and along its anterior margin. It is hypoplastic, flattened, and, instead of being in a sagittal plane, it appears more in front. Its margin is frequently absent. Its visibility during surgical intervention is rather limited.

COMMENTS ON CAUSES OF DISPLACEMENT

From the findings on the operating table, we tried to reconstruct the anatomic conditions as they occur after the shoulder trauma. *The most constant and characteristic change is the deformation of the angle of declination*¹. The angle of inclination is involved to a minor degree.

Figure 13 shows that the normal angle of declination is behind the transverse axis of the lower end of the humerus. If this is the case, the head of the humerus is in normal contact with the glenoid.

If the angle of declination increases by a backward displacement of head and neck of the humerus (the transverse axis of the lower end of the humerus remaining in the frontal plane), the contact surfaces between glenoid and head of humerus change (Fig. 14). If the declination increases by internal rotation of the transverse axis of the lower end of the humerus, those anatomical relations will be encountered as we found in our roentgenological and anatomical investigations: the head of the humerus will be brought in contact with the glenoid with its anterolateral pole. The epiphysis will be displaced backward, the greater tuberosity will be in front (Fig. 15).

After the joint capsule has been cut and the arm brought in external rotation, the epiphysis has normal contact with the glenoid, but the angle of declination remains unchanged and the axis of the lower end of the humerus will be rotated completely outward.

To re-establish normal anatomical conditions, which means to bring back in a frontal

¹The angle of declination is formed by the axis of the upper end of the humerus in relation to the transverse axis of the lower epiphysis, it is about 20 degrees, open backward and inward. The angle of inclination is formed by the axis of the shaft of the humerus and the axis of head and neck. It is about 130°-140°.

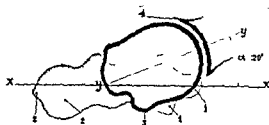


Fig 13 Angle of declination of neck of humerus. Upper and lower end of humerus projected in horizontal plane 1, Trochlea humeri 2 epitrochlea 3 capitulum humeri 4 epicondylus lateralis 3 upper end of humerus 4 glenoid cavity yy axis of head and neck xx transverse axis of lower end of humerus The angle between xx and yy is the angle of rotation or declination α . It is about 20 degrees and opens inward and backward

This irregularity is hard to explain, most likely it indicates a traumatic lesion

The glenoid, up to 3 or 4 years of age, does not differ appreciably in shape and development from the normal. Changes appear around the fourth year of life. First only a slight hypoplasia can be noticed which gradually increases to a real aplasia. This is especially true for the lower half which appears to be cut away. The joint margin is sometimes sclerotic. There is no neck of the scapula. Rather frequently in more severe inveterate cases (15 to 16 years) the lateral margin of the scapula runs directly into the glenoid. The

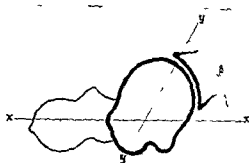


Fig 14 Figures 14, 15 and 16 show the changes in the configuration of the humerus after obstetrical shoulder lesion. The angle of declination is increased by backward displacement of the axis yy. The transverse axis of the lower end of the humerus xx remains in the frontal plane. The contact surfaces between head and glenoid change

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All these signs are associated with a general hypoplasia of the scapula, only the coracoid process and acromion appear larger, which fact is due to the oblique view in which the roentgenogram is taken (inclination of the scapula)

The clavicle very often shows signs of a fracture in the middle third, with callus formation in the first months of life, later with

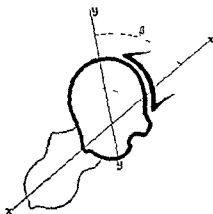


Fig 15 If the increase of the angle of declination B is associated with an internal rotation of the transverse axis of the lower end of the humerus xx the head has contact with the scapula only with its anterolateral pole. The epiphysis is turned backward and the greater tuberosity is in front. Such are the findings at surgical intervention

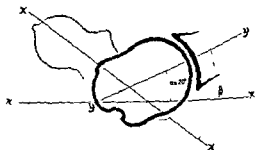


Fig 16 The epiphysis of the humerus retains normal contact with the glenoid after the capsule has been cut and the extremity turned outward. The transverse axis of the lower end of the humerus xx shows marked external rotation because there is no change in the angle of declination B . To re-establish normal anatomic conditions it is necessary to break the continuity of the humerus between epiphysis and diaphysis and to turn the lower fragment inward thus decreasing the pathologic angle B to the normal angle α

lateral displacement and retroversion of the epiphysis; (3) the complete absence of nerve lesions (electrical examination negative).

TREATMENT

During the first 2 years of life, the treatment is a conservative one for functional re-education. To prevent contracture in internal rotation, a shoulder spica cast is applied in abduction of 60 to 70 degrees and in maximal external rotation. The cast is changed after 1 month to increase external rotation. After two or three corrective casts, the joint and muscle contracture is usually overcome and a good degree of external rotation is obtained. A removable splint is then applied and physical therapy (heat, massage, exercises) started.

After the second year of life, the treatment must be surgical to correct the anatomical changes. According to Putti, the surgical treatment is characterized by two steps (1) myotomy and the capsulotomy of Sever, and (2) rotation-osteotomy of Putti (Fig. 17). The osteotomy is performed at a second operation in all cases in which retroversion of the epiph-

ysis has taken place, while in milder cases, the procedure of Sever is sufficient.

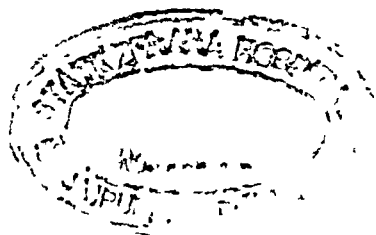
SUMMARY

1. Obstetrical shoulder lesions can be classified in three groups: (a) obstetrical joint trauma, (b) obstetrical paralysis, (c) mixed form (paralysis plus trauma).

2. Electrodiagnosis and roentgenological examination permit differentiation between joint trauma, paralysis, and the mixed form.

3. Obstetrical joint trauma is most frequent lesion observed. It leads to epiphyseal separation at the upper end of the humerus with characteristic clinical and roentgenological manifestations, to an inward and backward displacement of the upper fragment with an increase of the angle of inclination and declination.

4. The treatment of the sequelæ of the obstetrical shoulder lesion is surgical. In cases with retroversion of the epiphysis two operations have to be performed (1) the capsulotomy of Sever and (2) the rotation osteotomy of Putti.



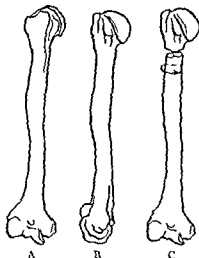


FIG. 17. Humerus after obstetrical shoulder trauma. A Neutral rotation epiphysis in retroposition B Complete external rotation, epiphysis is in normal contact with glenoid C Rotation osteotomy of Putti to bring the lower end of the humerus in a frontal plane

plane the transverse axis of the lower end of the humerus while head and neck remain in normal position, it is necessary to interrupt the continuity of the humeral diaphysis (Putti) (Fig. 16). By this the inner rotators of the shoulder will be relaxed, the external rotators are put under tension (Fig. 8).

It is of interest to know whether at the time of the epiphyseolysis the epiphysis rotates externally (Kuestner) or internally or whether the epiphysis remains in place and the diaphysis performs the internal rotation.

Our findings speak against Kuestner's hypothesis. If the epiphysis rotated outward and the diaphysis remained still, after consolidation internal rotation of the arm would bring the head of the humerus in full contact with the glenoid. If the epiphysis rotated outward and the diaphysis turned inward, further joint contracture in internal rotation would bring the epiphysis in a frontal plane. However, in all of our cases the epiphysis was completely retroverted and only the anterolateral pole was in contact with the glenoid.

If the epiphysis remains still and the diaphysis turns inward, the olecranon would have to come in a frontal plane to give a retroversion of the epiphysis. This has never been observed, even in rather severe cases.

It is therefore more justified to assume that after the epiphyseolysis a primary displacement of the epiphysis takes place backward and inward. Only this assumption explains all the findings.

To explain how, after trauma, the characteristic internal rotation of the arm develops, one has to consider the distribution of agonistic and antagonistic muscle groups. Upon the upper fragment, in the sense of external rotation, act the infraspinatus, teres minor, and in part, the supraspinatus muscles (the latter is mainly an abductor), in the sense of internal rotation only the subscapularis acts. No muscle can bring the lower fragment in external rotation while internal rotation can be brought about by the action of the pectoralis major, latissimus dorsi, and teres major.

Thus, Kuestner's hypothesis, that the upper fragment turns outward the diaphysis inward, would be based upon considerable muscle imbalance. Against it, however, speak clinical and roentgenological observations.

We believe that the primary cause of internal rotation is the defense position in the injured arm assumes (in the newborn exactly in the same way as in the adult), which means the arm is rested against the chest for immobilization and prevention of pain.

This primary cause is followed by secondary causes which help to stabilize the deformity: contracture of internal rotators and of the capsuloligamentous apparatus. Also the pronation of the forearm (due to gravity) helps to augment the deformity as the years pass by.

One could think that the displacement of the epiphysis is gradually acquired during the persisting contracture in internal rotation. However, against this speaks (1) the displacement of the bony epiphysis which is more marked in the first 2 to 3 years and later on there is improvement instead of aggravation, (2) the absence of displacement in cases of pure obstetrical paralysis even if by muscle contracture the arm is kept in internal rotation.

DIAGNOSIS

The diagnosis of the obstetrical shoulder joint lesion is based upon (1) the typical symptomatology characterized by rigidity of the shoulder joint, (2) the roentgenogram with

boilable varieties) which are manufactured in the United States, Austria, France, Germany, Great Britain, Holland, and Spain. The material comprised 14 brands of American made, and 22 brands of foreign made sutures. These brands, as well as all those examined during my previous investigations, were of current manufacture, and all of the firms were actively engaged in making and selling sutures when my purchases were made.

A total of 589 lots comprising 7,168 sutures was examined. Following the procedure adopted in all my previous catgut research, at least four sutures from each lot were first subjected to complete chemical analyses to determine the nature and amount of any chemical compound with which the sutures might be impregnated. Then, at least eight sutures of the same lot were tested in accordance with the bacteriological technique (5) previously outlined; except that the test organism now being used for controlling the growth-promoting properties of the culture medium is *Clostridium lentoputrescens*, since this is a slow-growing organism and most exacting in its anaerobic requirements.

The bacteria found in the non-sterile sutures were obtained in pure culture by the poured plate method, colonies were fished and the culture re-plated until pure culture was obtained. Anaerobic cultures were studied on freshly prepared cystein meat infusion agar plates. These plates were incubated at 37 degrees C. in jars in which anaerobiosis was provided by alternately exhausting with a vacuum pump and rinsing with pure carbon dioxide, after the method employed by Hartsell and Rettger. This process was repeated three times, and the jars sealed after the final exhaustion. Identification of the various bacteria was made in accordance with the procedures outlined in Bergey's *Manual of Determinative Bacteriology*, fourth edition, 1934; Ford's *Textbook of Bacteriology*, and Spray's "Tentative Key" (12). These comprised a study of (a) morphology; (b) spore formation and position, (c) cultural characteristics on solid and fluid media; (d) liquefaction of gelatin, (e) fermentation of various sugars; (f) production of indol, and (g) reduction of nitrates.

RESULTS

Of the 36 brands of catgut sutures examined, 15 brands, or 41 per cent, were found to be non-sterile. Of the 589 lots tested, 161 lots or 27 per cent contained non-sterile sutures.

From the non-sterile catgut sutures, 36 spore-forming bacterial species were isolated and identified; including 5 sporulating anaerobes (*Clostridium bifermentans*, *Clostridium fallax*, *Clostridium histolyticum*, *Clostridium sporogenes*, and *Clostridium welchii*), together with 31 aerobic and facultative spore-forming bacilli. Classification of this latter group into species presented a real problem, since the genus *Bacillus* has been overburdened with inadequately described species. As a result, the allocation of strains to the proper species within this bacterial genus is difficult and often uncertain. From the work done, it seems that most of the strains are closely related and belong either to the species *Bacillus mesentericus* or to *Bacillus megatherium*. However, other strains very closely resembled *Bacillus brevis*, *Bacillus cereus*, *Bacillus circulans*, *Bacillus cytaseus*, *Bacillus laterosporus*, *Bacillus mycoides*, *Bacillus polymyxa*, *Bacillus terminalis*, and *Bacillus vulgatus*. None of the strains conformed to all the cultural characteristics of *Bacillus subtilis*, as described by Bergey, which accounts for the absence of this species.

All the aerobic and facultative spore-forming bacilli, together with two species (*Clostridium bifermentans* and *Clostridium sporogenes*) of the sporulating anaerobes, are commonly considered non-pathogenic, but the three other species of sporulating anaerobes (*Clostridium fallax*, *Clostridium histolyticum*, and *Clostridium welchii*) are pathogenic.

The principal habitat of these bacteria is the soil; but some of the species are also found in the intestinal canal of man and animals, and some occur in gas gangrene wounds.

Some sutures of some brands of catgut contained aerobic and facultative spore-forming bacilli which are non-pathogenic, while in other sutures of the same lot were found pathogenic, sporulating anaerobes.

Upon chemical analyses of sutures of those brands of catgut which proved to be non-sterile, appreciable quantities of soluble chem-

THE BACTERIAL SPECIES FOUND IN NON-STERILE SURGICAL CATGUT SUTURES

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IN previous papers (1, 2, 3, 4) in which the results of my bacteriological researches of surgical catgut sutures were presented, I endeavored to emphasize the inefficiency and unreliability of the so called chemical sterilization of surgical catgut. I demonstrated that several brands of catgut sutures tested by my bacteriological method (5), were non sterile.

Bacteria in raw material Bacteriological examinations of 20 specimens of sheep intestines from Spain, England and Argentina revealed the presence of 13 different species of sporulating anaerobes of the pathogenic and non pathogenic varieties, and these were designated by Piening as follows: (1) *Fraenkel's gas bacillus* (*Bacillus welchii*), (2) *Bacillus novyi* of malignant edema, (3) *para anthrax bacillus* (*Vibrio septique*), (4) *Bacillus histolyticus*, (5) *Bacillus putrificus verrucosus* (*Bacillus sporogenes*), (6) *Bacillus putrificus tenuis* (*Bacillus bifementans*), (7) *Bacillus tertius*, (8) *Bacillus sphenoides*, (9) *Bacillus multifementans*, (10) *Bacillus cochlearius*, (11) *Bacillus tetanomorphus*, (12) *Bacillus tetani*, (13) *Bacillus lichenoides*. All these species except the last one are clostridium forms and, therefore, should have been so designated. The last species (*Bacillus lichenoides*) is not listed among the anaerobes in any standard work on systematic bacteriology, it may be the facultative anaerobe *Clostridium licheniforme* described by Weigmann.

In the United States a study (8) of 83 specimens of raw catgut revealed the presence of pathogenic spore forming anaerobes in 38 of the specimens examined. These comprised three species of gas gangrene organisms: *Clostridium novyi*, *Clostridium septicum* and *Clostridium welchii*.

While these bacteriological investigations of the raw material are of scientific interest, the chief concern of the surgical and hospital professions lies in the possible presence of living

bacteria in the finished product—surgical catgut sutures.

Gas gangrene infections In 1923 and again in 1925, pathogenic sporulating anaerobes were isolated (9) from sutures taken from the same batch of catgut as that used for surgical patients in whom postoperative gas gangrene had developed with fatal issue. The infections occurred in two hospitals in New York City and involved two brands of catgut sutures. The sporulating anaerobes found in these sutures included *Clostridium septicum*, *Clostridium sordelli*, and *Clostridium welchii*.

Bacteria in catgut sutures Regarding the kind of bacteria in contaminated catgut sutures, it has been stated (6) "While it is true that the majority of bacteria which contaminate catgut are non pathogenic anaerobic bacilli, the presence of gas forming anaerobic bacilli or the relatively more serious tetanus bacilli can never be excluded."

In spite of this statement, however, a search of the literature failed to disclose any reference to a systematic study of a large number of brands of catgut ever having been made for the purpose of determining the species of bacteria present in contaminated surgical catgut, and therefore, there did not appear to be any reliable data on which the foregoing statement could be based.

MATERIALS AND METHODS

Because of the widespread interest which my investigations of the sterility of surgical catgut sutures aroused, it seemed desirable to identify the various species of bacteria present in non sterile brands of catgut. Accordingly, during the years 1935, 1936 and 1937, I purchased periodically from various sources in the open market several lots of each kind and variety of catgut sutures (plain, chromic, tanned, Brady catgut, chloramine, copper, iodized, formalized, pyoktann, silver, catgut, etc., including the boilable and non-

West Virginia University School of Medicine, for his assistance in clarifying the nomenclature of the sporulating anaerobes and for his valuable suggestions. Also, to Dr Stanhope Bayne-Jones, Dean and Professor of Bacteriology, Yale University School of Medicine, and to Professor C-E A Winslow, Department of Public Health, Yale University School of Medicine, for their helpful suggestions.

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ical compounds were found, and the physical characteristics of these sutures indicated that they had been subjected either to a low degree of heat or no heat

SUMMARY AND CONCLUSIONS

1 A comprehensive bacteriological study extending over a 3 year period was made of 36 brands of American and foreign made catgut sutures, of which 15 brands, or 41 per cent, were found to be non sterile, and of the 589 lots tested, 161 lots, or 27 per cent contained non sterile sutures. This study, therefore, confirms my previous researches of catgut sterility (2, 3)

2 During this study, 36 spore forming bacterial species were isolated and identified. These comprised 5 sporulating anaerobes together with 31 aerobic and facultative spore forming bacilli which grew usually under aerobic conditions but sometimes when cultured anaerobically

3 A significant result of this investigation was that all the bacteria isolated from the non sterile sutures are spore formers

4 The presence of spore forming bacteria in catgut sutures constitutes a potential danger to the patient for two reasons: first, as so ably pointed out by Small, bacterial spores may remain viable although inactive for a considerable period of time during which bacterial activity may occur through tissue damage as a result of mechanical or chemical injury, concurrent infection, or even cold which inhibits phagocytosis, and, second if the sterilizing process does not include heat of a sufficiently high degree and long enough duration to kill the non pathogenic spore formers, it is quite obvious that it cannot be depended upon to destroy those pathogenic species (such as *Clostridium tetani*) which have a higher thermal death point and which may be present in other sutures of the same lot of catgut

5 All except three species (*Clostridium fallax*, *Clostridium histolyticum*, and *Clostridium welchii*) of the bacteria found in non sterile sutures during this investigation are commonly considered non pathogenic. It should be borne in mind however that while some of the sutures of some brands of catgut

contained aerobic and facultative spore forming bacilli which are non pathogenic, yet in other sutures of the same lot of catgut were found pathogenic, sporulating anaerobes

6 Most of the aerobic and facultative spore forming bacilli isolated during this study use a great deal of oxygen for their growth. If these bacteria are present in catgut sutures which are introduced into tissues, they may consume all the oxygen which is present, thus bringing about anaerobic conditions which, in turn, favor the growth of such anaerobes as *Clostridium fallax*, *Clostridium histolyticum*, *Clostridium welchii* and other gas gangrene organisms if they should also be present. Again, while it is probably true that *Clostridium bifermentans* and *Clostridium sporogenes* are commonly non pathogenic when rabbits and guinea pigs are inoculated subcutaneously with pure cultures, nevertheless when catgut sutures containing these sporulating anaerobes are buried in the tissues of surgical wounds, these organisms possibly may prove to be pathogenic

7 Chemical analyses of sutures of the 6 brands of catgut which were found to be non sterile revealed appreciable amounts of soluble chemical compounds. Moreover, their physical characteristics indicated that they had been exposed to a low degree of heat or even none at all. Therefore in the preparation of these non sterile sutures, entirely inadequate heat or none whatever was used for sterilization purposes reliance having been placed apparently upon chemical methods. On the other hand, sutures of those brands of catgut which were found to be absolutely sterile showed every evidence of having been subjected to high heat sterilization. As emphasized in a former paper (1)

"1 The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable

"2 Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures"

It is a pleasure to acknowledge my gratitude to Mr J. Roger Porter, Laboratory of Bacteriology, Yale University for his advice and valuable assistance in classifying the aerobic and facultative spore forming bacilli isolated during this investigation and to Professor Robb Spalding, Spray Department of Bacteriology and Public Hygiene

technical problem. However, the sphincter of Oddi may be attacked directly. Its musculature may be permanently paralyzed by actual surgical division of its fibers. Transduodenal sphincterotomy may be a comparatively new term in operative nomenclature, but it is not a new procedure because transduodenal choledochotomy for impacted papillary calculi has been done for years and in this operation, division of the sphincter is essential in order to extract the stone. Recently Archibald has reported several cases in which the sphincter was divided for spasm, and del Valle has sectioned it transduodenally for "odditis." This latter condition manifests itself pathologically by the presence of a retracted sphincter which partially obstructs the free flow of bile.

Transduodenal papillotomy is not without risk aside from the immediate postoperative dangers of peritonitis and duodenal fistula because subsequent duodenal deformities due to adhesions may also result in physiological disturbances. Besides the eventual efficacy of transduodenal sphincterotomy for sphincteric spasm can only be evaluated after more information is gained by a careful follow-up of these patients. There are still many questions to be answered. Does division of the sphincter permanently destroy its action?



Fig 1 The sphincterotome with knife blade open. The shaft, which is 16 centimeters long and 4 millimeters in diameter, has a flattened tip measuring 35 by 6 by 2.5 millimeters. The shearing blade which fits into a slot in the tip, has a thickness of 1.5 millimeters and an effective cutting length of 11 millimeters.

Does the scar resulting from this section cause a secondary contraction of the papilla, and does this result in a stenosis with biliary stasis?

Certain of the obvious objections to transduodenal sphincterotomy may be eliminated by endocholedochal sphincterotomy. Recently the results of dividing the sphincter through the common bile duct by means of a sphincterotome (Fig 1) in cholecystectomized dogs were published (2). The operation which was perfectly feasible, effected a definite reduction in the function of the sphincter mechanism and was not followed by any evidence of ascending infection of the biliary tract. This procedure was then tried on a series of cadavers. Its safety was demonstrated as far as

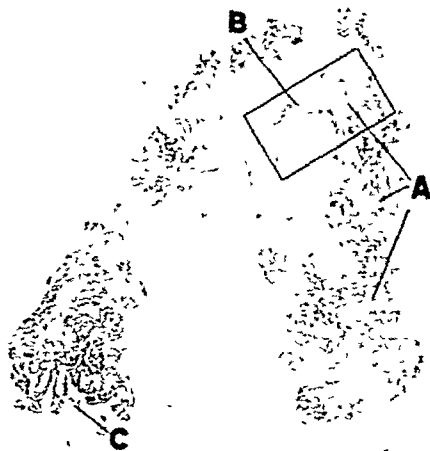


Fig 2 Photomicrograph of a portion of the tissue punched out by the sphincterotome. Note A, the smooth muscle fibers of the sphincter of Oddi, B, the mucosa and the glands of the wall of the choledochus, and C, the mucosa of the duodenum. $\times 27$

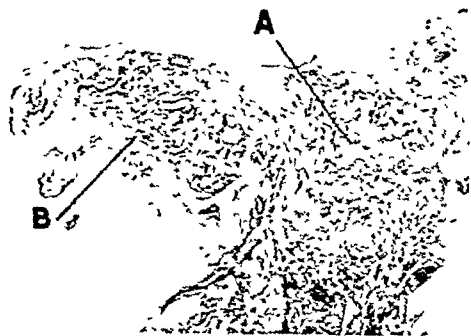


Fig 3 Part of Figure 2. This photomicrograph has been given a greater magnification to show clearly A, smooth muscle fibers, as well as B, the folds and glandular structure of the mucosa of the terminal portion of the choledochus. $\times 135$

ENDOCHOLEDOCHAL SPHINCTEROTOMY

RALPH COLP M D F A C S and HENRY DOUBILET, M D, New York New York

PHYSIOLOGICAL disturbances of the sphincter of Oddi bear an important relationship to certain types of acute pancreatitis, gall bladder disease, the post cholecystectomy syndrome, the dyskinesias of the biliary tract and some forms of transient jaundice. Spasm of the sphincter which is a basic factor in the production of these pathological states, has recently been demonstrated by roentgenologic x ray studies of lipiodol injections of the choledochus (2, 7), together with pharmacological studies of the intraductal pressure recorded kymographically, according to the method described by Katz.

It is extremely important, therefore, in order properly to treat many of the aforementioned conditions that spasm of the sphincter of Oddi be relieved either temporarily or permanently. It is well known that some of the patients with sphincteric spasm respond readily to medical therapy especially those cases which presumably have their origin in either endocrine disturbances or imbalances of the sympathetic nervous system. Other patients have been definitely benefited by rest, dietetic measures and duodenal lavage. But quite often these conservative measures fail and the persistence of severe and distressing symptoms make surgical intervention imperative. It is in those cases especially, when careful surgical exploration fails to disclose any gross pathological alterations that attention should be focused upon a dyskinesia of the sphincter of Oddi as the possible cause of the symptomatology.

There are several surgical procedures which may be employed to relieve this localized muscular spasm.

Forceful dilatation of the sphincter obtained by the passage of graduated sounds through the common duct into the duodenum will undoubtedly paralyze the musculature for a long time. This simple method advo-

cated by many appears rather crude and traumatic. It has been complicated by an ascending anaerobic infection from the duodenum and deaths from Welch infections due to *Bacillus welchii*, have been reported.

Biliary duodenal intubation accomplishes practically the same result as instrumental dilatation. The indwelling tube insures not only a free internal drainage of bile, but by its mechanical presence maintains a persistent dilatation of the sphincter until the spontaneous elimination of the tube. This method advocated by Duval and Walzel, aside from certain technical difficulties, does not seem particularly dangerous, especially if a tube of large caliber is used and sufficient of its length protrudes into the intestine. The method, however, has never gained great popularity.

There is another procedure which is advocated. Many European surgeons when confronted with dilatation of the choledochus associated either with impacted calculi, or sphincter spasm or papillary stenosis, prefer an anastomosis between the common duct and the duodenum eliminating entirely the sphincter mechanism and shortcircuiting the flow of bile. The operation of choledochoduodenostomy is attended by certain dangers. One of the most important of these, theoretically at least is an ascending infection from a duodenal reflux. In spite of the fact that gas-roentgenological x ray studies in these cases often reveal the presence of barium in the common bile the clinical incidence of ascending infection is quite rare. This has been verified by the reports of Sasse, Floercken, and Peterman who have used choledochoduodenostomy in a large series of cases.

All of these surgical procedures, however, have certain definite disadvantages. Dilatation of sphincter and biliary duodenal intubation are only temporary measures because eventually the sphincter will regain its tone and periodic muscular spasms may recur. Choledochoduodenostomy as a cure for simple sphincter spasm presents rather a difficult



Figs 6 left and 7 Lipiodol studies before (Fig 6) and after (Fig 7) the administration of morphine in a patient whose kymographic studies are recorded in Figure 3. Note that both in Figure 4 (manometric resistance 165 millimeters) and in Figure 6 (manometric resistance 160 millimeters), the terminal ends of the hepatic ducts are visualized to an equal extent. The spasm produced by morphine in the intact sphincter of Oddi (Fig 7) raised the resistance to such a height (370 millimeters) that the very fine biliary radicles were visualized before lipiodol entered the duodenum.

ectomy, she made an uneventful recovery and was discharged June 18, 1933.

She remained well but for a short time when she began to experience episodes of pain which were described as rather characteristic. A few days previous to the onset of the attack, the patient experienced severe hunger. The pain then started in the right lower quadrant, radiating around the right side to the back, and upward to the right shoulder and arm. There was nausea but no vomiting. The pain lasted for a short time and either terminated spontaneously or was relieved by an injection of morphine sulphate, at times $\frac{3}{4}$ of a grain being required (nitroglycerine was without effect). After the attack subsided, there was residual tenderness in the right upper quadrant and along the course of the colon, and pruritus which was followed by a generalized urticaria. Jaundice was never noticed.

During the past year, the patient also complained of menstrual disturbances in that her periods occurred irregularly every 2 or 3 weeks. The bleeding occasionally was slight and lasted a few days and at other times it was more profuse, and persisted from 10 to 12 days. It was noted too, that her weight increased from an average of 150 to about 175 pounds.

Because of the patient's unusual sequence of symptoms, it was decided to hospitalize her for a period of observation. She was readmitted to the Beth El Hospital on February 15, 1937. The following laboratory reports were of significant value:

Blood chemistry, February 17, 1937, showed: serum albumin, 4.3 milligrams per cent; serum globulin, 2.4 milligrams per cent; total serum protein, 6.7 per cent; glucose, 0.86 milligrams per cent; urea, 11.5 milligrams per cent; creatinine, 1.2 milligrams per cent; cholesterol, 110 milligrams per cent; cholesterol ester, 54 milligrams per cent.

Galactose tolerance test, February 19, 1937, showed: blood sugar—fasting, 0.87 milligrams per cent; $\frac{1}{2}$ hour, 0.95 milligrams per cent; 1 hour, 0.93 milligrams per cent; $1\frac{1}{2}$ hours, 0.94 milligrams per cent; 2 hours, 0.40 milligrams per cent; urinary sugar negative in all 5 specimens.

Glucose tolerance test, February 20, 1937, showed: blood sugar—fasting, 0.72 milligrams per cent; $\frac{1}{2}$ hour, 0.95 milligrams per cent; 1 hour, 0.96 milligrams per cent; $1\frac{1}{2}$ hour, 0.93 milligrams per cent; 2 hours, 0.90 milligrams per cent; urinary sugar negative in all 5 specimens.

Bile drainage—A and C bile was obtained, but no B bile. Microscopic examination showed no cholesterol crystals or other abnormal constituents.

Gastric analysis with alcohol test meal showed:

	Free hydrochloric acid	Total acidity
Fasting	1	16
$\frac{1}{2}$ hour	58	76
1 hour	26	40

Blood count showed, 12,800 white cells; polymorphonuclears, 63 per cent; lymphocytes, 37 per cent.



Figs. 4 (left) and 5 (right) fluoroscopic study 21 days after sphincterotomy. The resistance of the common duct sphincter was so low (Fig. 4) that the terminal portions of the hepatic ducts and the upper end of the choledochus were not outlined before lipiodol entered the duodenum. Following the administration of morphine (Fig. 5) the duodenal wall was clearly seen to become spastic, compressing the intramural portion of the choledochus. The resultant increase in the resistance was slight, since only the terminal portion of the hepatic ducts was visualized before lipiodol entered the duodenum. These studies confirm the results of the kymographic tracings (Figs. 8 & 9, 10).

visible injury to the duodenum and pancreas was concerned. The method was recently tried clinically.

The following case, presumably one in which the clinical picture was due to periodic episodes of sphincter spasm is of interest because the attacks apparently were relieved by endocholedochal sphincterotomy.

L. C. a married female 24 years of age was referred to me by Dr. I. A. Feder of Brooklyn, New York, to whom we are indebted for her history and laboratory studies. She was first admitted to the Beth El Hospital, Brooklyn, New York, on August 5, 1932, and discharged during November, 1932. Her past history was practically negative except that for 2½ years following her second pregnancy, she had experienced attacks of right upper quadrant pain which radiated to the back and right shoulder.

The present illness began rather abruptly with high fever, chills, delirium and rigidity of the neck. The physical examination revealed findings suggestive of typhoid fever, which all laboratory data confirmed. During the fourth week of her illness the temperature instead of subsiding continued in an intermittent fashion. The patient complained of severe pain in the right upper quadrant of the abdo-

men, and on physical examination a mass was noted in this region. There was no jaundice and the white blood count was normal. In spite of the fact that the patient was critically ill, a laparotomy was performed under spinal anesthesia on September 14, 1932.

An enormously distended partially necrotic gall bladder with a pericholecystic abscess completely enveloped by omentum was found. There was a stone in the cystic duct. A cholecystotomy was made and a cigarette drain was inserted to Morrison's pouch. Cultures of pus from the gall bladder were positive for *Bacillus typhosus* and *Staphylococcus albus*. The postoperative course was rather stormy, and although at one time there were clinical signs of subphrenic abscess, the condition subsided spontaneously. The patient was finally discharged with a biliary fistula, which eventually closed in 2 months' time.

The patient then began to experience attacks of severe biliary colic which were relieved only when the fistula spontaneously reopened with the free discharge of bile and pus. Because of the repeated episodes, the patient was admitted to the Brooklyn Jewish Hospital for exploration May 30, 1933. The operation which was performed under spinal anesthesia revealed a chronically inflamed gall bladder with stones in the cystic duct. The common duct was probed and found free. Following a cholecy-



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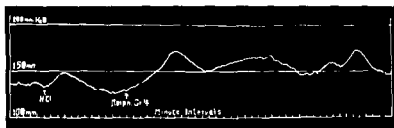


Fig 8 Kymographic record of the resistance of the sphincter of Oddi 10 days after endocholedochal sphincterotomy. The resistance was found to measure 130 millimeters of water. Following intraduodenal instillation of dilute hydrochloric acid the resistance rose to 145 millimeters falling to the original level in 10 minutes. The hypodermic injection of morphine caused the resistance to rise to 145 millimeters at which level it remained for the duration of the experiment.

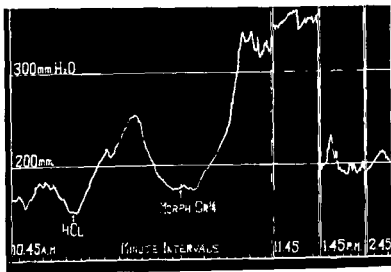


Fig 9 Typical kymographic tracing in a patient in whom the sphincter had been left intact. The original resistance (160 millimeters of water) rose to 255 millimeters following the local application of dilute hydrochloric acid. The spasm produced by morphine raised the resistance to 370 millimeters of water.

Wassermann and complement fixation tests were negative. Basal metabolic rate was -22 . Roentgenogram of the sella turcica was negative. Examination of the right upper quadrant by flat x-ray plate showed a peculiar linear shadow density about $\frac{3}{4}$ inch long. Its cause could not be made out.

After her discharge from the Beth El Hospital February 26, 1937 she was given thyroid and pituitary gland extracts without relief. In view of the repeated attacks of pain exploratory laparotomy was advised since it was felt that the patient was suffering either from periodic attacks of spasm of the sphincter of Oddi or possibly a common duct stone.

The patient entered the Mount Sinai Hospital on March 25, 1937 and was discharged April 11, 1937.

An exploratory operation was done under avertin supplemented by gas oxygen and ether anesthesia on March 26, 1937. The liver and gall bladder bed appeared normal. There was no evidence of a cystic duct. The common bile duct which was normal throughout its course did not appear dilated and on aspiration was found to contain clear golden yellow bile. The stomach, duodenum and pancreas which were clearly visualized were normal. The uterus was retroverted but normal in size and shape. The adnexa felt normal. There were many intra-peritoneal adhesions which were divided in order to expose the common bile duct adequately. By means of the Hoffman punch a biopsy specimen was taken from the liver and pancreas. (These were sube-

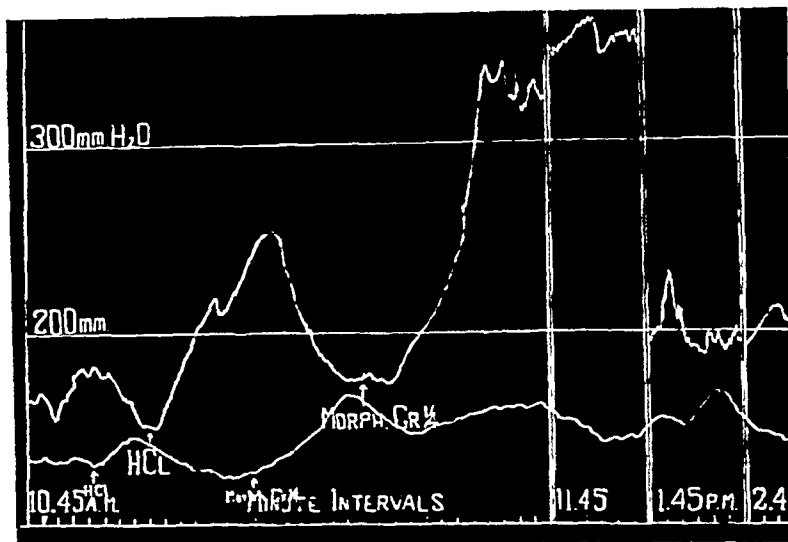


Fig 10 The tracing from the patient in whom the sphincter of Oddi was sectioned (Fig 2) superimposed upon the tracing in a patient with an intact sphincter (Fig 3) The difference in the levels of the tracings clearly shows the small part played by the duodenal musculature and the important part played by the sphincter of Oddi, especially after the local effect of hydrochloric acid and the effect of morphine

quently reported as showing no significant changes.) The common bile duct was incised between Allis clamps and, probed without difficulty, and did not contain any calculi. The sphincterotome (Fig 1) was introduced into the common bile duct and through the sphincter into the duodenum. The knife was opened and the instrument withdrawn until it firmly infringed upon the sphincter. The knife was closed, thus dividing the sphincter without difficulty. The instrument was withdrawn, and the piece of tissue which had been punched out was removed from beneath the blade and sent to the pathological laboratory for study (Figs 2 and 3). A T tube was inserted into the common bile duct and sutured about the tube with four interrupted chromic sutures. Two rubber dam drains were placed to the region of the common duct, one above, and one below the tube. The abdomen was closed in layers using chromic throughout, with silk and pincettes for the skin.

Postoperative course There was an immediate postoperative rise of temperature to 103 degrees. This gradually fell to normal on the fifth day. There was free drainage of bile through the choledochostomy tube on the second day, at which time the return from an enema revealed a normal stool containing abundant bile. Lipiodol studies (Figs 4, 5, 6, 7) and manometric studies after the method of Katz (Figs 8, 9, and 10) which are herewith recorded, were then made on the tenth and eleventh days after operation. The T tube which was removed on the twelfth day was not followed by any further discharge of bile. The patient was discharged on the sixteenth day.

The patient has been seen repeatedly, the last examination taking place on February 23, 1938. She had been perfectly well and has had no recurrence of her previous attacks.

It seems fair to assume that the attacks resembling biliary colic described by the patient, were presumably due to spasm of the sphincter of Oddi. This conclusion is further verified by the operative findings and the fact that following endocholelechoal sphincterotomy, the attacks ceased. The cause of the spasm is open to question. The period of hunger preceding the episodes of pain, the increased tolerance to sugar as noted in the glucose and galactose tolerance tests (the latter almost a typical course of a true hypoglycemia), the menstrual disturbances, the gain in weight, and a low basal metabolic rate, point to an endocrine disturbance as the most likely etiological factor in the production of the muscular irritability. Conservative therapy, i.e., treatment by the administration of glandular extracts, was without effect. There is no doubt that the sphincter was divided endocholelechoally because the specimen removed by the sphincterotome revealed biliary and duodenal mucous membrane and some

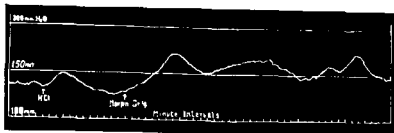


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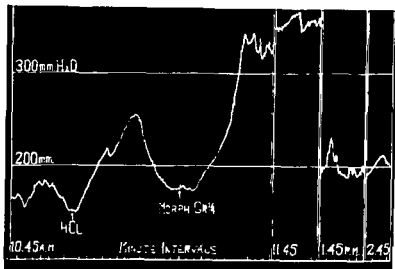


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CLINICAL SURGERY

HALLUX VALGUS

HARRY C STEIN, M D, F A C S, New York, New York

THE perplexing and intriguing problem of 'bunions' has been attacked from many interesting and diverse angles by both foreign and American investigators

Despite the many excellent contributions in the literature many necessary anatomical and physiological details, however, seem not always to have been sufficiently considered. This is especially true in the rôle of the sesamoids.

The writer having reviewed a number of cases operated upon at various clinics, undertook an independent investigation of the subject. Etiological, anatomical, physiological, pathological, pathophysiological, radiographic, and clinical data were considered in the light of a predominantly physiological rather than a plastic surgical repair.

An operative procedure which seems best to meet the surgical indications was evolved.

ETIOLOGY

In walking, as described by Hiss, the weight of the body converges from the "cuboid" (weight bearing) stream to join the "scaphoid" (walking) stream, and the combined load is finally distributed along the under surface of the great toe. Any factors, extrinsic or intrinsic, tending to shift this load more medially on the big toe, favor the development of hallux valgus.

Extrinsic factors include high heeled, pointed, short or poorly fitted shoes, and short or toe-constricting hose.

Among the more common intrinsic factors are torsional deformities involving the thigh, leg or foot, faulty foot posture, flat foot, adducted supinated forefoot, excessively high arch with compensatory forefoot pronation, overaction, spasm, or contracture of the adductor hallucis muscle, imbalance between peroneus longus and tibialis anticus muscles, excessive varus or short first metatarsal bone, congenital or acquired defects, or excessive rounding of the head of the first metatarsal, hyperextensibility at the metatarso-internal cuneiform or internal cuneiform-scapoid joints, and accessory scaphoids.

From the Hospital for Joint Diseases, service of Harry Finkelstein, M D

The deformity primarily is merely a functional postural adaptation; later it becomes structural in character.

ANATOMY

Sesamoid bones These play a most important rôle not only in the development but also in the surgical correction of hallux valgus. It is essential to bear in mind that: (1) These bones are intracapsular. They articulate by means of convex facets on their superior surfaces, with corresponding longitudinal grooves on the inferior aspect of the first metatarsal head. (2) They are contained in the double tendon of the flexor brevis muscle which inserts (via conjoined tendons) into opposite aspects of the base of the proximal phalanx (Fig 1). Thus they move in whatever direction the great toe moves. This partly accounts for their displacement in hallux valgus. (3) Held together by the glenoid ligament they move as one bone. (4) Together they form a movable groove for the protection of the flexor longus hallucis tendon. They are situated more posteriorly when standing and anteriorly when the toe is dorsiflexed, as in walking. (5) The outer margin of the lateral sesamoid affords attachment for the powerful adductor obliquus tendon just before it merges into the formation of the conjoined tendon (Fig 1).

First metatarsal bone 1 There is a normal varus of this bone of between 8 and 12 degrees, due to the obliquity of its articulation with the internal cuneiform bone. This adds strength to the longitudinal arch. This articulation, in addition, permits of about 10 to 15 degrees of lateral, and a lesser degree of vertical mobility thus adding flexibility to the arch.

2 When the forefoot is supinated varus of the metatarsals is relatively increased. On pronation, it diminishes. This affects the inner four metatarsals (Fig 2). Normally, voluntary adduction of the forefoot is combined with inversion (supination), abduction, with eversion (pronation). The resistance of the ground in walking, as referred to by Steindler, may induce secondary compensatory detorsional changes in the position of the forefoot. Thus, in flat foot the forefoot eventually becomes supinated. The converse is true in high arch.

muscle (Figs 2 and 3), and the x ray findings following lipiodol injection and the kymographic tracing bear witness to its division. In spite of the fact that the sphincter had been divided, the duodenal musculature and the obliquity of the entrance of the common bile duct through its wall acted as an efficient protecting valve against the reflux of duodenal contents (Fig 5). Clinically, the patient has remained in good health and has been free of attacks of colic following the division of the sphincter of Oddi.

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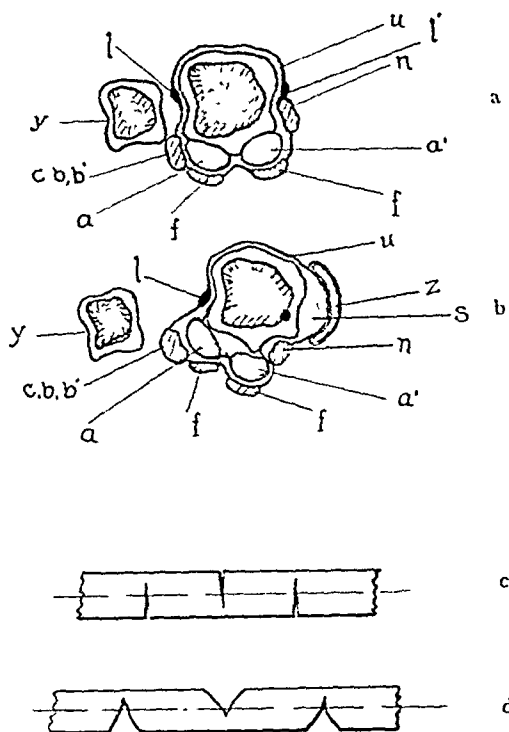


Fig 3 a, Transverse section through head of normal first metatarsal bone b, Similar section in a case of hallux valgus a a', Sesamoid bones, c, b, b', conjoined adductor hallucis tendon, n, abductor hallucis tendon, f, flexor brevis tendons, u, capsule, y, head of second metatarsal bone, s, fibrocartilaginous capsular thickening, z, overlying bursal sac, l, l' lateral ligaments

The abductor hallucis muscle, in addition to its action in maintaining the alinement of the toe, also has a splinting effect on the first metatarsal bone. Acting in a line parallel to this bone, and using its head as a fulcral point, the abductor hallucis pushes this bone toward the second metatarsal. The adductors, arising from the remaining metatarsal bones, in opposing this action, tend to keep all the metatarsals together and in normal alinement.

This effect also is lost, as the abductor tendon goes plantarward, resulting in the development of metatarsus varus (Fig 6) (Where the fore-foot is supinated, the inner four metatarsals may be involved, as can be seen in Figure 7.) Later there is the occurrence of spreading of the metatarsal heads, and dropping of the anterior arch. Since the metatarsal of the great toe no longer is fixed, the remaining metatarsals likewise are not fixed.

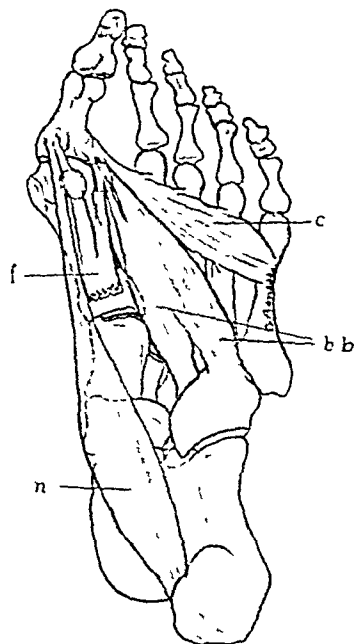


Fig 4 Displacement of adductor and abductor muscle groups and sesamoids in hallux valgus n, Abductor hallucis, f, flexor brevis, b, b', adductor obliquus, c, adductor transversus

With this concept, one may readily understand why in cases of hallux valgus there is usually found the co-existence of metatarsus varus, spreading of the metatarsal bones, depression of the anterior arch and displacement of the sesamoids.

PATHOLOGY

Following are described typical pathological changes to be found in the usual well developed case of bunions.



Fig 5 Lateral displacement of sesamoids in hallux valgus

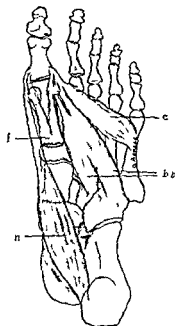


Fig 1 Normal arrangement of abductor and adductor muscle groups of great toe *f* flexor brevis muscle two heads *n* adductor hallucis *b b* adductor obliquus two heads *c* adductor transversus

3 The articular cartilage covering the first metatarsal head continues for about $\frac{3}{8}$ inch over its lateral surfaces. This cartilage forms a gliding mechanism for the obliquely placed collateral ligaments.

4 The tibialis anticus and peroneus longus tendons insert into opposite aspects of the base of this metatarsal. These maintain its physiological balance.

PHYSIOLOGY

As emphasized by McBride the great toe is maintained in normal forward alignment by the physiological opposing action of the abductor and adductor muscle groups. These insert by means of conjoined tendons into opposite aspects of the base of the proximal phalanx (Fig 1). The abductor group comprises the medial head of the flexor brevis and the abductor hallucis muscles. The adductor group consists of the lateral head of the flexor brevis, the adductors obliquus and transversus.

This opposing action is possible only so long as the abductor tendon retains normal position in its groove on the inferomedial aspect of the metatarsal head (Fig 3a). (This tendon is here blended with the capsule.)



Fig 2 Left High arch with compensatory forefoot pronation. Right Same foot in inversion (supination). Note change in direction of four inner metatarsals.

Pathological physiology. In the development of hallux valgus as a result of the pathophysiological forces the abductor tendon migrates. It moves from its groove on the inferomedial aspect of the first metatarsal head plantarward beneath the inferior margin of the head then lateralward. It lodges in the groove for the medial sesamoid. Here it becomes firmly wedged, resulting in a fixed eversion of the great toe (Figs 3b and 4). The sesamoid bones are thus crowded laterally. The medial one goes into the groove for the lateral sesamoid and the lateral one into the interspace between the first and second metatarsal heads (Figs 3b 4 5). This lateral subluxation is augmented by pull of the obliquus tendon via its lateral sesamoid attachment (Fig 4).

In its displaced position the opposing action of the abductor (to the adductors) is lost. It now acts as a flexor and evor of the great toe. The unopposed adductors and the bow string (long short flexor and extensor tendons), all tend to increase the hallux valgus deformity.

The medial portion of the capsule, the internal lateral ligament and the slightly squarred lateral margin of the metatarsal head offer resistance to these deforming forces. In most instances, however, this is inadequate and soon overcome. During this interval the apparent paradoxical condition of pronounced metatarsus varus with eversion of the toe and displacement of the sesamoids without a corresponding hallux valgus deformity may be found.

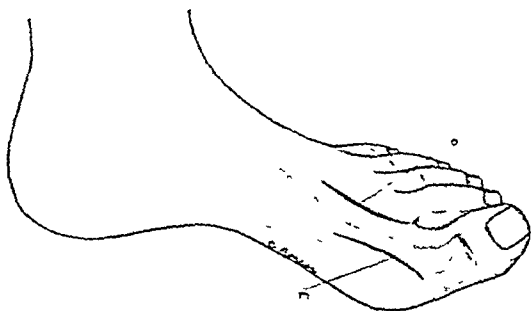


Fig 9 Drawing of skin incisions. The eversion of the great toe is indicative of displacement of the abductor tendon into the groove for the medial sesamoid

4. In advanced and long standing cases, there are secondary adaptive bony changes of the metatarsal head. These consist mainly of hypertrophy and "squaring" of its medial margin. This may be sufficiently marked to cause lateral shifting of the entire articular surface (Fig 10)

5. In arthritic cases, there may be hypertrophy and lipping of the articular margins and sesamoids

The so called "exostosis" removed at operation is usually a myth. On examination, it is found to consist essentially of a section of the inner margin of the normal or hypertrophied cartilage covered head, plus a segment of the markedly thickened, dense, fibrocartilaginous capsule, and the thin, overlying bursal sac. Roentgenographically, what clinically appears to be an exostosis directly under the skin, is found to be a dense, soft tissue enlargement (Fig 8)

The "enlarged" joint, so commonly referred to in connection with these cases, is essentially an over-prominence of the head, due to the metatarsus varus, accentuated by the capsular thickening and the valgus position of the toe. The bony component of this enlargement is relatively small

SURGICAL CONSIDERATIONS

From a surgical viewpoint, the problem of hallux valgus is similar to that of club foot or any

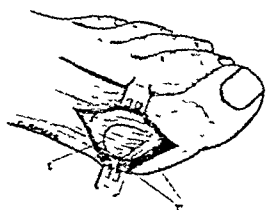


Fig 11 *t*, Modified Silver capsular flap incision, *r*, abductor tendon

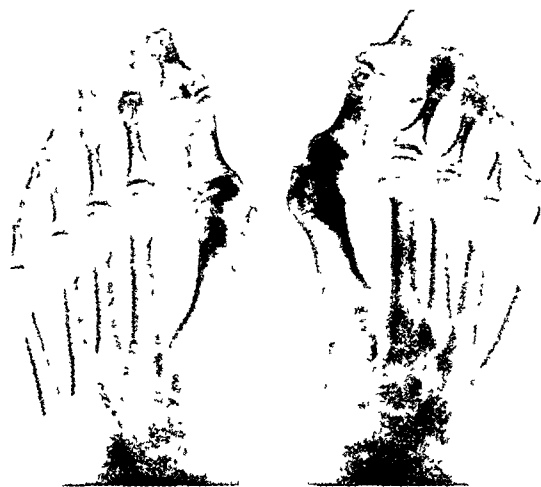


Fig 10 Hypertrophy of the mesial margin of the first metatarsal head, especially on the right side, sufficient to cause almost the entire articular surface to face laterally

contractural deformity. The primary deforming elements are found on the contracted side

The surgical requirements include: (1) on the lateral aspect, thorough division of the contracted deforming structures, (2) on the medial aspect, bursectomy plus capsuloplasty fashioned to replace the abductor tendon and correct the eversion and valgus of the toe, (3) removal of any obstructing bone from the metatarsal head

The contracted structures on the lateral aspect consist of (1) adductor obliquus attachments to the lateral sesamoid, (2) the external lateral ligament, (3) the capsule between the two structures, (4) frequently, the lateral head of the flexor brevis muscle

Their division is of primary importance. It permits unresisted correction of the valgus deformity and allows the sesamoids to slip into place. A main causative factor in recurrence is

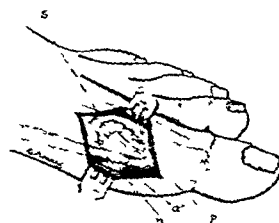


Fig 12 Capsular flap in position of correction *a'*, Medial sesamoid, *n*, abductor tendon; *p*, position of capsular flap before correction; *s*, position of capsular flap following correction and suture. Note the replacement of the abductor tendon. Correction of eversion of the great toe

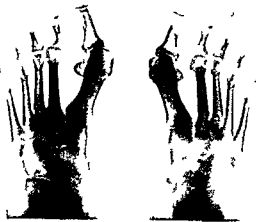


Fig 6 Varus of first metatarsal bones. Note marked in crease in space between first and second metatarsal heads indicating corresponding elongation of transverse inter metatarsal ligament

Lateral aspect 1 The capsule here is contracted in its longitudinal and transverse diameters. That part between external lateral ligament and external sesamoid is especially involved (Fig 3b)



Fig 8 Note the marked thickening and increased density of the capsule overlying the bunion joint and the relatively small bony component of this enlargement



Fig 7 Varus of the inner four metatarsal bones. Note the comparatively slight spreading between the first and second metatarsal heads on the right side in spite of the marked first metatarsus varus

2 The external lateral ligament is fore shortened

3 The external sesamoid is displaced laterally and slightly dorsally into the interspace between the first and second metatarsal heads. Here it is firmly anchored by the contracted oblique attachment, as well as the contraction of the capsule above its lateral margin (Figs 3b and 4)

4 The lateral head of the flexor brevis is contracted

Medial aspect 1 The capsule here is the seat of marked fibrocartilaginous thickening. Overlying this is a thin walled bursal sac (Fig 3b)

2 The tubercle of origin of the internal lateral ligament is somewhat hypertrophied

3 The abductor tendon is displaced inferiorly and laterally dislodging the sesamoids (Figs 3b and 4)

Associated changes 1 The great toe is maintained in a position of valgus eversion, and slight downward subluxation (Fig 9)

2 There is an exaggerated varus of the first metatarsal with a corresponding spreading and elongation of the transverse intermetatarsal ligament between it and the adjacent head (Fig 6) (Frequently however especially in cases of supinated forefoot the inner four metatarsal bones go into varus together Fig 7)

3 The metatarsal head is inverted in relation to the toe

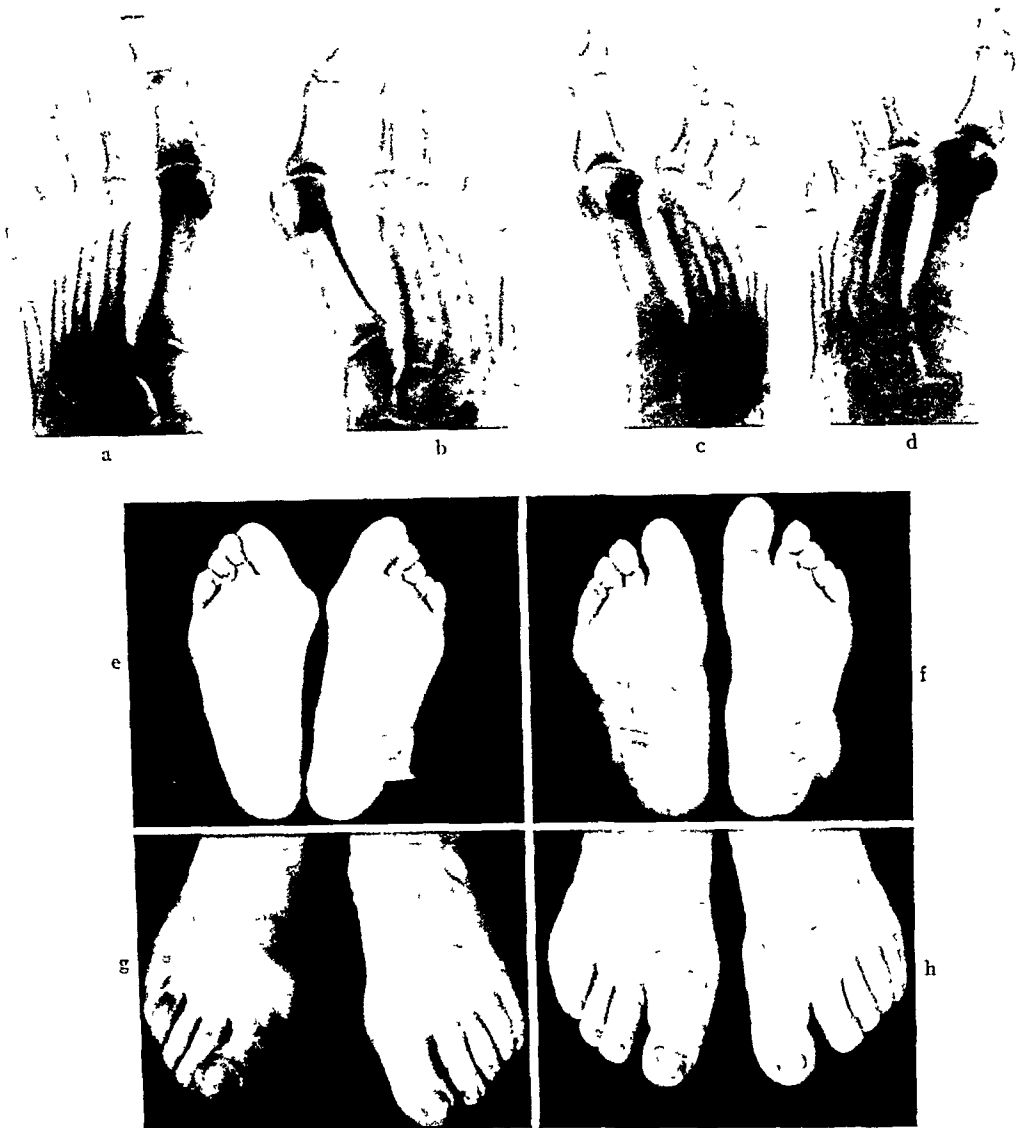


Fig 16 a and b, Roentgenograms of both feet before operation, c and d, after operation, e and g, photographs of both feet before operation, f and h, after operation

the lateral sesamoid is prevented from retracting, (3) control of the sesamoids via the great toe, so essential for their reposition, remains intact

Similarly, the various plastic and fusion operations at the base of the first metatarsal for bony correction of its varus are objectionable in ordinary cases for the following reasons (1) they result in diminished strength and flexibility of the longitudinal arch—especially the function of the ball of

the big toe—, (2) unless fusion is accomplished at an exact angle, the ball of the big toe is caused to remain either too high or too low, with consequent secondary static disturbances, (3) an undesirable convergence of the first and second metatarsal bones may result; this is especially true when the varus involves all inner metatarsal bones (Fig 7), (4) adequate spontaneous correction usually occurs after the valgus and eversion

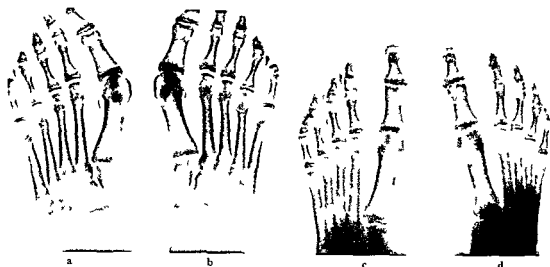


Fig 13 a and b Both feet before operation c and d Both feet after operation Note the spherical first metatarsal heads the replacement of the sesamoids the im-

proved relationship of the first metatarsal internal cuneiform joints and the diminished metatarsus varus

eliminated This procedure alone without any additional work on the medial aspect has yielded satisfactory results (Fig 17c) This has been noted especially in cases of recurrence due to their inadequate division at the original operation

Cases with secondary hypertrophic changes of the medial margin of the metatarsal head acting as a bone block against complete correction, require removal of the obstructing one This restores congruity of the articular surfaces

In cases in which severe osteo arthritic changes have taken place with lateral shifting of the articular surface (Fig 10) the more radical resec-

tion operations are to be considered However if the symptoms are localized to the bursal region the more conservative operations directed at alleviation of pain only are preferable

The writer has found it inadvisable and rarely necessary to sever the conjoined adductor tendon from its insertion into the base of the proximal phalanx The capsular incision to be described plus complete division of the lateral sesamoid attachments of the obliquus tendon and occasionally the lateral head of the flexor brevis answer the same purpose, i.e. of permitting unresisted correction of the valgus of the great toe This procedure has the advantages (1) that the lateral muscle balance of the toe is preserved (2)

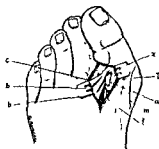


Fig 14 Attachments of the usual two obliquus heads to the lateral margin of the lateral sesamoids Dotted line indicates line of incision for separating these structures from this sesamoid a Lateral sesamoid b adductor obliquus heads c adductor transversus muscle f flexor brevis hallucis l external lateral ligament m medial incision x line of severance of adductor attachment to lateral sesamoid

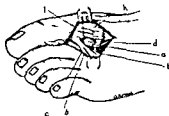


Fig 15 Semi-oblique view to show deeper structures Dotted area d indicates severance of obliquus attachments from lateral sesamoid Note proximal head of obliquus b only is divided completely The heavy dotted line indicates line of hockey stick incision through lateral ligament and capsule between it and underlying sesamoid a Sesamoid b adductors obliquus c adductor transversus h hockey stick incision l lateral ligament

A second, dorsally curved, incision is now made on the medial aspect of the joint (Fig 9), thus exposing the bursa, the thickened fibrocartilaginous capsule, and the displaced abductor tendon.

The bursal sac is excised. A modified Silver capsular flap is so fashioned as to permit fore-shortening of the elongated capsule, derotation of the everted toe, and replacement of the displaced abductor tendon (Figs. 11 and 12).

Before anchoring this corrective flap into position, the head of the metatarsal is inspected. If hypertrophy along its medial margin is sufficient to act as a bone block against complete correction of the valgus, or to result in undue joint tension after correction, the obstructing bone only, (mostly dorsomedially), is chiseled away. As far as possible, the ball of the toe, the groove for the medial sesamoid, and the inner cartilaginous rim at the periphery are conserved. The tubercle of origin of the internal lateral ligament, if enlarged, as well as any osteophytic processes, is removed.

If, after correction of the valgus, the extensor tendons are short, these may be corrected by triple subtotal sections (Figs 3c and d).

Holding the toe in the desired degree of correction and in neutral position, the capsular flap is now anchored snugly. Silk sutures are preferable (Fig 12). Overcorrection is avoided. Freedom of mobility should be possible before and after the anchoring sutures are applied.

The skin incisions are closed, and dressings and adhesive support are applied. No plaster-of-Paris cast is necessary.

Postoperative care includes active exercises. Weight bearing is permitted after 2 weeks. A Jones bunion splint is worn at night for several months. Static foot disturbances are treated and properly fitting postoperative bunion last shoes are prescribed.

REPORT OF CASES

A series of fifteen cases have been operated upon by this method, first utilized in 1933. Three illustrative cases are presented.

CASE 1. E. L., aged 42 years, with painful bunions of 7 years' duration (Figs 16, a and b, and c and g). The procedure described was performed on both sides. Figures 16c and d, f and h show postoperative corrections. Note the corrected position of the sesamoid bones. Result 1 year after operation was very satisfactory.

CASE 2. M. T., aged 12 years, with painful bunions of 1 year's duration (Fig 17a and b). This procedure was performed on the left side (Fig 17c). On the right side, nothing but division of the oblique tendon from the sesamoid and the capsular incision was done. Satisfactory correction was maintained in a 1 year follow-up study (Fig 17d).

CASE 3. L. H., aged 15 years, painful bunions of 1 year's duration. The procedure described was performed

on both sides. Satisfactory correction was maintained in a 3 year follow-up study (Figs 13, c, d).

SUMMARY AND CONCLUSIONS

Some of the more pertinent features of the etiology, anatomy, physiology, pathological physiology, and pathology of hallux valgus have been outlined. This included: (1) a conception of the mechanism of the development of hallux valgus deformity, (2) the importance of the abductor hallucis tendon in maintaining the integrity of the forefoot, (3) the rôle of the contracted structures on the lateral aspect, and especially the oblique attachments to the lateral sesamoid in the causation and in the recurrence of the deformity, (4) a discussion of the "exostosis" myth.

The importance, in the surgical correction of hallux valgus, of replacement of the sesamoids, after their preliminary thorough mobilization has been stressed.

An operative procedure, which, in the author's opinion, seems best suited to meet the surgical requirements, has been described and illustrative cases presented.

The author wishes to express his indebtedness to Dr. L. Haboush for his assistance in the experimental work, and to Mr. George Asness for illustrations and diagrams.

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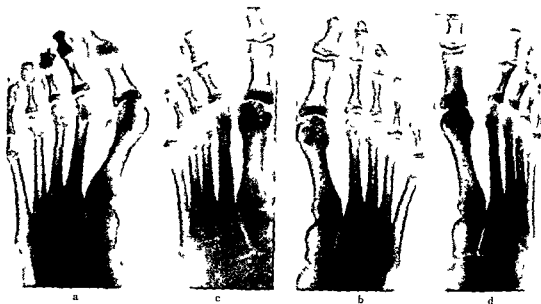


Fig. 17 a and b Both feet before operation c and d after operation

of the toe has been overcome, and the sesamoids replaced (5) the 'bony deformity' at this joint in most instances, is more apparent than real. It is dependent on the degree of inversion of the fore foot, the angle at which the x rays are taken and the altered relationship of the joint surfaces (Figs 13a, b, c, d).

Operations of this nature are reserved for those comparatively rare cases in which a definite bony deformity, or the presence of an intermetatarsal bone as described by Truslow, maintains an unyielding exaggerated varus of this metatarsal.

OPERATION

Fungus infection, if present, is preliminarily treated.

Operation is performed preferably under a tourniquet. A longitudinal incision about $1\frac{1}{2}$ inches in length is made on the dorsum of the foot in the interval between the first and second metatarsal heads. This extends from behind the web directly posteriorly (Fig. 9).

Dissection is carried down keeping close to the lateral aspect of the capsule, thus exposing the lateral sesamoid with its oblique attachment, the conjoined tendon, and the lateral head of the flexor brevis muscle.

With the joint line as a guide, the external lateral ligament with the part of the capsule intervening between it and the lateral sesamoid is divided by a 'hockey stick' incision (Fig. 15).

This is begun by dividing the external lateral ligament at the joint line, carried downward, then posteriorly, in the interval between the lower margin of the head and the lateral sesamoid and extended well back.

The attachments of the oblique tendon to the now exposed lateral sesamoid are thoroughly divided. The hindmost fibers must be included. These usually are attached to its posterior tip as a separate bundle (Fig. 14). (The attachment of the conjoined tendon to the base of the proximal phalanx distally, and the red fibers of the flexor brevis muscle proximally, act as guides to insure its complete division.) The conjoined tendon gains length. Frequently the lateral head of the flexor brevis also requires division. This should be performed proximal to its sesamoid attachment. A definite give can be felt when the binding structures at the posterior sesamoid tip are released. It is but rarely that a triple subtotal section of the oblique tendon is found to be necessary.

Unresisted correction of the valgus without any tendency to spring back, or undue joint tension is now possible. The sesamoids slip into place voluntarily.

The heads of the first and second metatarsals are now approximated by means of a heavy silk or fascial suture. This is taken through the opposing aspects of their capsular bases, or through adjoining drill holes.

THE VALUE OF DELAYED SINGLE PEDICLE SKIN FLAPS IN PLASTIC REPAIR OF THE SCALP

WARREN B DAVIS, M.D., F A C S, Philadelphia, Pennsylvania

AN extensive raw surface in the scalp area, whether due to a deep burn, some degree of avulsion or other severe trauma, is usually healed with difficulty. Blair, Brown, and Byars have secured splendid results by their method of using thick split grafts. For avulsion of the scalp W. D. Haggard regards Thiersch and Reverdin or pinch grafts the only ones applicable. In an avulsion case, A. G. Banks found Thiersch grafts to be only partly successful, and later used a caterpillar graft from the abdomen to the forearm, thence to the scalp successfully. In an avulsion case, G. F. Mitchell closed a denuded area of the cranium 6 inches in diameter by the use of a series of multiple double pedicle flaps and some small single pedicle flaps.

From the Department of Surgery, Jefferson Hospital
Read at the sixth annual meeting of The Society of Plastic and
Reconstructive Surgery, St. Louis, Missouri, October 22, 1937

In the very extensive scalp defects extending over the vault of the cranium, from one side to the other, one is apt to be content if a healed surface is secured by any method of skin grafting or even grafts plus cicatrization, without particular regard to the cosmetic result obtained, since some type of wig can be utilized to hide a disfiguring result.

If a large scalp defect, however, is limited to one side of the head, one should carefully consider the ultimate cosmetic result when the plan of plastic repair is outlined. In such cases, I strongly advocate the use of one or more delayed single pedicle flaps from the sound portion of the scalp as the major part of the operative procedure, supplemented, if necessary, by buried pinch grafts Thiersch or split grafts, to cover any remaining wound surface. The area from which a large delayed pedicle flap has been swung, should be



Fig 1

Fig 1 M A January 9, 1936 Granulating wound 29 months after partial destruction of scalp by a hot air hair dryer



Fig 2

Fig 2 April 16, 1936 Appearance of burned area 52 days after the delayed single pedicle flap was placed in position across the midportion of the granulating surface. Buried pinch grafts were placed in the granulations above and below the flap, 14 days before the flap was moved to

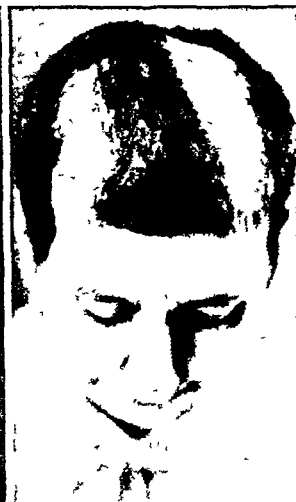


Fig 3

present location. Flap held perfectly. Epithelialization above flap complete, while that below flap is not entirely complete. Some areas of scar tissue unstable, melting away at time of menstrual periods, then reforming.

Fig 3 April 16, 1936 Scalp healed. Area above pedicle flap shows result from buried pinch grafts. Area on left side, from which pedicle flap was swung, shows result obtained by full-thickness skin graft from abdomen.

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bone and periosteum became covered with a thin layer of vascular granulations which had a tendency to develop a very delicate unstable cicatricial surface which partly, or sometimes completely, disappeared during the menstrual periods.

In the planned repair, a pedicle flap, 2 inches wide, was outlined over the left side of the top of the head, extending from the occipital region to a point just posterior to the frontal hairline. Measurements insured sufficient length for it to be swung across the midportion of the wound later and sutured to the skin margin anteriorly. The flap was elevated, *both* ends being left attached, then replaced, and sutured into its original position. One week later the anterior attachment was divided, the flap elevated to the occipital attachment, and again replaced and sutured. After another week's delay, the flap was elevated, swung across the midportion of the burned area, and sutured into position. A free full thickness skin graft, the exact size of the pedicle flap, was taken from the abdomen and used to cover the area from which the delayed flap had been removed. At the time of the primary loosening of the flap, small pinch grafts, taken from the thigh, had been buried in the thin granulation tissue above and below the area to be occupied by the flap. All areas healed well, as shown in Figures 2 and 3.

During the following 3 months, it was observed that the healing in the area below the pedicle flap was not entirely stable, small points melting away at menstrual periods, serous fluid oozing out for 3 or 4 days then healing again. This did not occur on the area above the flap covered area. To secure satisfactory scalp tissue to cover the unstable area, a twice delayed single pedicle flap was then prepared in the midline of the posterior portion of the scalp, in the same manner as that used for the first flap, extending from the crown of the head to the margin of the scalp in the cervical area. One week after the second elevation of the flap, the thin unstable epithelium was removed from the area below the first flap, and the second flap placed in position and sutured. By widely undermining the skin margins about the area from which the second flap was taken, and by making a lateral incision at the upper and lower extremities of the raw surface, rectangular flaps were formed, and,

by means of traction sutures, were advanced sufficiently almost to cover the raw area. All areas healed promptly and have remained stable (Figs 4 and 5). It has been interesting to observe that the hair on the transplanted flaps has grown more rapidly and is more lustrous than that on the rest of the scalp.

The functional results have been entirely satisfactory, the cosmetic results are as shown in Figures 6 to 8. The patient is happy with the perfectly comfortable scalp and freedom from the necessity of any artificial covering or wig.

The method outlined is favored for these reasons:

1. A delayed pedicle flap develops an adequate blood supply, thus is more certain to live than is any type of free graft.

2. The thickness of the new scalp is nearer normal and does not develop atrophic spots on the surface.

3. Any surrounding scar tissue is more stable than it would be around any type of free graft.

4. The outline of the flaps can be planned so as to give symmetry in the distribution of hair bearing scalp surface, thus insuring better cosmetic results.

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Fig 4



Fig 5



Fig 6

Fig 4 September 9 1936 Appearance 64 days after delayed pedicle flap was swung from occipital region to cover the unstable area below the first flap shown in Figure 2

Fig 5 September 9 1936 Further improvement in texture of grafted area

Fig 6 September 21 1937 Amount of scar in area from which second flap was swung

immediately covered with an accurately cut full thickness free skin graft from the abdomen

The method of combining the several types of skin grafting will be described and the results obtained shown by a series of photographs of an old unilateral burn of the scalp thus treated

CASE H 1045 M A female aged 40 years (Fig 1) referred by Dr L C Darrah Reading Pennsylvania January 6 1936 29 months after a burn of the right temporal

and parietal areas and part of the anterior occipital and posterior frontal regions by an electric hot air hair dryer which cooked the scalp of the whole area to the periosteum and in some points to the bone. The heating coil in the dryer was out of order but the increasing heat was so gradual that the high degree was not realized until the hair caught fire. Tannic acid was used in the primary treatment followed by varying periods of treatment with benzocaine ointment salt solution irrigations and compresses boric acid solution compresses and a gentian violet tragacanth mixture. As the months passed the



Fig 7

Fig 7 September 25 1937 When hair is combed the occipital scar is invisible



Fig 8

Fig 8 September 2 1937 Hair arranged to show final appearance of grafted areas and hair dressed



a

Fig 1a Bronchiogenic carcinoma, left upper lobe, resembling aneurysm of aorta



b

Fig. 1b Lateral view, same case. A well defined circular shadow, apparently not contiguous with the vascular shadow, is noted which suggests mediastinal tumor rather than aneurysm

"The disease occurs much more frequently in men than in women, almost in the relation of 75 per cent in males to 25 per cent in females." In our study of 549 cases compiled since 1926 the relation is 85 per cent in males to 15 per cent in females

AGE

Regarding age an analysis of 364 cases, including 164 cases reported in this paper, reveals that the majority of cases occur in the interval between 40 and 60 years. Adding our figures to those of Brunn (4), making a total of 940 cases, 65 per cent were between 40 and 60 years. This was also reported in a study of 96 cases at the Mayo Clinic where 61 per cent were found to be between 40 and 60 years of age. In our group of primary carcinoma of the bronchus, the range in age at the time of admission to the hospital was from a minimum of 33 years and 7 months to a maximum of 68 years and 1 month, the average or mean age being 45 years and 7 months. The range in ages at time of onset of symptoms in a group comprising 140 where onset could be determined with reasonable precision was from a minimum of 32 years and 1 month to a maximum of 67 years and 6 months, the average or mean

age at onset of symptoms being 45 years and no months.

RACE

In this series of 164 cases of carcinoma of the bronchus, 154 were white men and 10 colored. In the 57 cases reported by Rosedale and McKay, 51 were white and 6 colored. Arkin and Wagner had 12 colored patients in their series of 135 cases. Jaffe (14) found that the total incidence of pulmonary carcinoma was higher in the white race than in the colored race, namely, 1.7 per cent of all autopsies in the white race and 1.0 per cent of all autopsies in the colored race.

FAMILY HISTORY

Although the family history was not recorded in 16 cases, in the remaining 148 cases the findings were interesting inasmuch as in 28 cases (31 instances of carcinoma), or 19 per cent, there was a family history of cancer, and in 11 cases (12 instances), or 7.4 per cent, there was a family history of tuberculosis. In 3 cases there was a family history of both tuberculosis and cancer, namely, in 2 cases the mother had died of tuberculosis and the father of carcinoma of the stomach, respectively. In the third case a brother

CARCINOMA OF THE BRONCHUS

A Clinical and Pathological Study of 164 Cases

JUSTIN J. STEIN, M.D. and HOPE L. JOSLIN, A.B., A.M., Hines, Illinois

THE recognition and treatment of primary carcinoma of the bronchus has assumed a role of increasing importance. Although many recent papers report an actual increase in carcinoma of the bronchus, greater diagnostic accuracy, more complete examinations including bronchoscopic study and removal of tissue for biopsy must not be overlooked—also the fact that individuals are now living longer as compared with twenty years ago. Graham (12) states: "The fact that the pathologists are now recognizing more of the small obstructive tumors instead of stopping their examinations at the complications in my opinion accounts for much of the present impression that bronchiogenic carcinoma has actually greatly increased in frequency in recent years. Regardless of whether or not the increase is real or apparent carcinoma of the lung is a relatively common disease."

INCIDENCE

Brunn in a statistical analysis of necropsy reports from 1898 to 1916 found 488 primary carcinomas of the lung in 192,271 necropsies, or 0.24 per cent. From 1916 to 1934 there were 71 cases in 33,308 necropsies or 0.21 per cent. He mentions figures prior to 1900, however, it is difficult to evaluate reports of this period since so little stress was placed upon lung diseases at that time.

Rogers reported 50 cases of primary lung cancer found in 2,209 autopsies done on persons 30 or more years of age at the Pathologico-Anatomic Institute of the University of Vienna from October 1920, to November 1930. The incidence in this group was 2.26 per cent.

Rosedale and McKay reported that in 4,670 autopsies in the period 1915-1934 466 malignant neoplasms of all types were found and of this number 7.5 per cent were bronchiogenic carcinomas.

Jaffe (14) in 1935 reported 871 carcinomas in 6,800 autopsies, of this number 12.47 per cent were carcinomas of the lung. In 1931 in a

statistical analysis of 4,500 autopsies performed between 1915 and 1918 in Vienna, also reported by Jaffe (15), the incidence of carcinoma of the lung among the carcinomas was 10.73 per cent. In these reports the slight increase is more apparent than real.

A study of primary admissions to the Hines Hospital in the 6½ year period from January 1, 1931, to July 1, 1937, reveals a definite increase in primary carcinoma of the bronchus. In Table I are figures comparing the number of primary carcinomas of the bronchus each year with 4 other types of carcinomas as well as with all admissions for carcinomas during a 6 year interval.

This report is based upon an analysis of the clinical features presented by 164 patients having primary carcinoma of the bronchus in whom the diagnosis was established by postmortem examination (100 cases), by histological examination of tissue removed through the bronchoscope (21 cases), by other biopsy examinations (13), or by clinical and roentgen ray evidence (30 cases). In each instance the end result is known constituting a 100 per cent follow up.

SEX

An analysis of 549 cases reported by various authors from the literature shows the ratio of males to females to be 5.6 to 1 respectively.

Regarding this item, Brunn in his statistical analysis of 576 cases published in 1926 states

TABLE I — INCIDENCE OF PRIMARY CARCINOMA OF BRONCHUS

Mal ward	01	02	1933	034	1935	036
Carcinoma—bronch	7	6	10	14	3	45
Carcinoma—larynx	7	7	8	17	7	24
Carcinoma—lip	82	11	30	70	70	94
Carcinoma—rectum	2	25	10	7	55	44
Carcinoma—stomach	6	32	7	35	4	54
All admissions for carcinomas	406	58	507	46	591	694
Percent carcinoma—bronch compared with all carcinomas	7	2.8	5.4	5	5.4	6.5

Because of economy in as a marked reduction in admissions occurred 1933

From the Tumor Clinic and Tumor Research Unit, Veterans Administration, Hines, Illinois.

Published with the permission of the Medical Director of the Veterans Administration who assumes no responsibility for the opinion expressed or conclusions drawn by the authors.



Fig 3a



Fig 3b

Fig 3a Bronchiogenic carcinoma, right upper lobe, complicated by secondary abscess

Fig 3b Bronchiogenic carcinoma, left upper lobe, complicated by extensive secondary infection. While the multiple abscesses dominate the picture, the x-ray features of bronchostenosis are also demonstrated

Fig 3c. Bronchiogenic carcinoma, left upper lobe, complicated by large secondary abscess. X-ray features of bronchostenosis are also noted in this case. Figures 3a, 3b, and 3c illustrate the difficulties encountered in diagnosis when secondary infection is present



Fig 3c

veterans to various types of gas during the World War has been very thoroughly discussed by Gilchrist and Matz

Although reports have been made stating that tarred streets predispose to the formation of carcinoma of the lung, yet the incidence is just as high where these conditions do not exist. Allen is of the opinion that carcinoma of the lung is no more common among the coal miners of Pennsylvania than in the other population of Pennsylvania

SYMPTOMS

The symptoms of carcinoma of the bronchus are the result of bronchostenosis with its associated pathology, ulceration of the mucosa, or extension of the tumor. Atelectasis is commonly associated with obstruction of the bronchus. Later bronchiectasis develops and abscess formation. As a result of this pathology, there will be pain, cough, dyspnea, and scant or profuse puru-

lent sputum. If a blood vessel is injured as a result of ulceration of the bronchial mucosa, hemorrhage may be produced or the sputum streaked with blood. Chills, fever, and leucocy-



Figs 2a and 2b Anterior and lateral views of bronchiogenic carcinoma showing collapse of the l_{ap} and complete obstruction of left main bronchus just distal to the bifurcation

died of pulmonary tuberculosis and the mother of carcinoma of the bladder. Vague histories, such as "father died of chronic lung trouble" were not included. With more authentic or definite information it is thought the figures might be slightly higher.

OCCUPATION AND ETIOLOGY

Although an exhaustive study was made of the various occupations in this group, no conclusions of any significance could be drawn. At least 75 different occupations were represented, the largest group being farmers or common laborers. Eight, or 5 per cent of the patients had been coal miners but 4 of these also had been employed in other occupations. In addition there were 2 patients whose occupations conceivably might have had some bearing upon the disease. One patient had worked originally as an ore miner, later as a metal polisher and motor assembler. A second patient had been employed for 7 years as an emery polisher inhaling fine particles of emery dust.

Rosedale and McKay state that 75.4 per cent of the patients listed in their group of 57 were employed in occupations requiring exposure to dust or other irritating atmospheric factors. It is

difficult to evaluate properly the part that dust and irritative atmospheric factors play in the etiology of carcinoma of the lung, especially in patients coming from large cities or industrial centers. There have been no conclusive facts shown as yet to prove that the above are of major importance.

Theoretically, trauma is to be taken into consideration in speculating upon etiology. In this series of cases there was no history of injury of any significance. However among these veterans there were 8 who had been subjected to war gas with resulting residuals and complaints of dyspnea, cough, pleurisy, bronchitis, recurrent attacks of pneumonia. In the latter instance one patient stated that in the attacks of pneumonia the left lung had always been the involved lung. Later he developed carcinoma of the left main bronchus. With the exception of 2 cases, both of whom underwent mustard gas poisoning, the type of gas is not mentioned in our histories. One of these patients was the individual previously mentioned who later was employed as an emery polisher so that there are further theoretical complications and conjectures regarding etiology in his case. The entire subject of exposure of

TABLE II — PRINCIPAL SYMPTOMS

Symptom	No. of cases	Symptoms	No. of cases
Cough	131	Night sweats	18
Loss of weight	129	Anorexia	7
Chest pain	127	Heart palpitation	1
Dyspnea	110	Dysphagia	4
Weakness	105	Orthopnea	7
Expectoration	72	Pain other than chest	3
Blood streaked sputum—hemoptysis	72	Hip, leg, various joints	40
Gastro-intestinal discomfort	32	Shoulder	17
Hoarseness	29	Arm	17
		Head	14
		Back	14
		Abdomen	7

acute bronchitis. In one-third of his patients the onset was not unlike an acute respiratory infection.

Approximately one-third of our patients also described their initial symptom as "heavy cold," "flu," "chill and fever," or had been diagnosed "pneumonia" or "pleurisy." A few additional patients described early symptoms as "asthma" or "bronchitis." In Farrell's cases, the initial symptom had been present a year in more than half the patients before a physician was consulted.

The principal symptoms noted in the cases at this hospital are shown in Table II.

Comparing the symptoms in these cases with those enumerated in other reports, cough, loss of weight, dyspnea, chest pain are most commonly found. However, loss of weight is generally not an early complaint.

The physical and roentgen observations are most often the result of associated pathological conditions, such as bronchitis, abscess, bronchiectasis, pleurisy with or without effusion, atelectasis, et cetera. Quite often the tumor may be obscured by associated pathological conditions and the diagnosis made difficult upon x-ray examination.

The most significant physical findings in our cases are shown in Table III.

ROENTGENOLOGICAL FINDINGS

The findings when typical are that of a unilateral density in the hilum with its apex directed toward the periphery of the lung. Quite often the lateral border of the density blends in with the veil-like shadow of the atelectatic lung resulting from the bronchostenosis. The ribs are narrowed on the affected side, the trachea pulled to that side and the diaphragm elevated. The entire hemithorax is smaller than that of the opposite side. Atelectasis is one of the most common find-

ings in the lung. Occasionally the shadow is distinguished from that of a pleural effusion. When complete obstruction has taken place, the air distal to the tumor is absorbed and the lung collapses. Bronchiectasis may follow the tumor growth is located in the region of the lung, having no connection with the bronchus, causing erosion of ribs or vertebrae, a condition of the terminal bronchioles should be noted (so called Pancoast type of tumor). Recently one of the authors of this paper (JJS, 24) reported a series of 8 cases of carcinoma of the apex of the lung (so called superior pulmonary sulcus type). Six of the cases were in the right apex and 2 in the left apex. Histological specimens were obtained in 5 of the cases, 3 were squamous cell carcinomas and 2 adenocarcinomas. The 3 remaining patients are still living. It is interesting to note that 3 of these cases had been previously diagnosed as tuberculosis and 1 as neuritis.

A large number of the far advanced cases have many associated complicating pathological factors which confuse the picture. Bronchiectasis, abscess cavities, pleural effusion and lymphadenopathies may overshadow the lesion in the hilum. Metastatic lesions in the lung are generally multiple, seldom produce pulmonary symptoms until late, and rarely cause bronchostenosis. That a metastatic lesion may, however, simulate a primary carcinoma of the bronchus was dramatically shown by a case of hypernephroma recently observed by the authors, in which a single metastatic lesion in the lung surrounding an upper lobe bronchus produced a bronchostenosis with the characteristic roentgen-ray findings of a primary carcinoma of the bronchus. The metastatic nodules have a smooth outline as compared with the irregular single shadow of the primary



Fig 4 Bronchiogenic carcinoma right lower lobe demonstrating characteristic x ray findings with atelectasis of this lobe

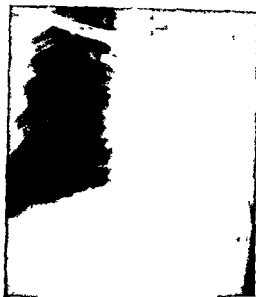


Fig 5 Bronchiogenic carcinoma demonstrating x ray findings with complete obstruction of left main bronchus. Note shift of mediastinal structures to affected side

tosis are caused by the formation of abscesses about the tumor and are generally seen late in the disease. More than half of the patients will have fever at a late stage in the disease.

Funk in reporting 61 cases states the onset of symptoms was usually insidious, although there were also many with sudden pain in the chest, hemorrhage, dyspnea or symptoms resembling



Fig 6 Bronchiogenic carcinoma. Characteristic x ray appearance. Complete obstruction of middle lobe bronchus.

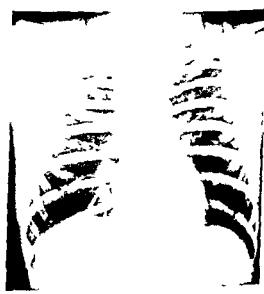


Fig 7 Superior sulcus tumor right apex (Pancoast type) producing partial destruction of second rib

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		Back	14
		Abdomen	7

TABLE III — PHYSICAL FINDINGS

Physical signs	Number of cases
Dullness	137
Diminished breath sounds	117
Restricted mobility	113
Râles	88
Diminished fremitus	65
Nodes positive	57
Pleurisy (including pleural effusion)	52
Abdominal changes	46
Atelectasis	40
Chest wall or cervical vessels engorged	33
Vocal cord changes	25
Eye changes—choked discs or other significant changes	25
Clubbing of fingers	16
Horner's syndrome	7

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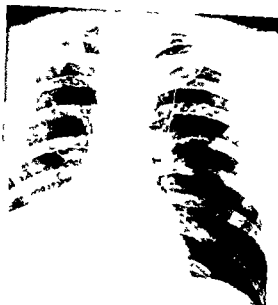


Fig 4 Bronchiogenic carcinoma right lower lobe demonstrating characteristic x ray findings with atelectasis of this lobe

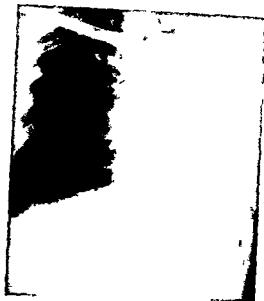


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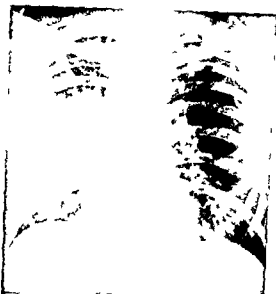


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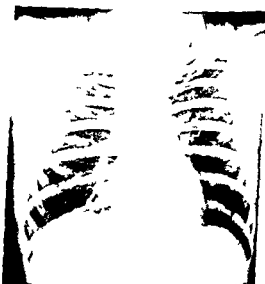


Fig 7 Superior sulcus tumor right apex (Pancoast type) producing partial destruction of second rib

TABLE VI.—LOCATION OF CARCINOMA IN LUNG
(100 AUTOPSIED CASES)

Right side	No of cases	Left side	No of cases
First order	43	First order	30
Trachea, carina and first order	2	First order and carina	1
First and second order	1	Second order	2
First order and carina	2	Grossly diffuse	2
Second order	6	Origin undetermined	1
First, second and third orders	1		
Terminal bronchioles	3		
Grossly diffuse	4		
Origin undetermined	1		
Both sides			
First order and carina	1		
Summary	Right 63	Left 36	Both sides, 1

Brunn in a study of 626 case reports, found the heart to be involved in 21 per cent of the cases and the suprarenals in 14 per cent.

The location as finally determined from an examination of autopsied cases demonstrated a greater incidence of cancer in the right bronchus than the left. This corresponds to findings reported by others. The precise location (cases coming to autopsy) is given in Table VI.

Table VIII shows the co-existing diseases or conditions which were found in an analysis of these cases.

With regard to tuberculosis, we are of the opinion that tuberculosis in the presence of carcinoma is a coincidence. It is difficult to believe that either disease causes the formation of the other in the same person. Jaffe (14) found that 7 of his 100 autopsied carcinoma of the lung cases also had tuberculosis. However, there was no case of carcinoma formation from the metaplastic epithelium of an old tuberculous cavity. In many cases of early tuberculosis, the patients consult the physician because of a "generally run-down" feeling, loss of appetite and fatigue following slight exertion, whereas in cases of early carcinoma of the lung the most common symptoms are pain in the chest, cough, and dyspnea.

Syphilis of the lung is rare and quite difficult to diagnose, and such a diagnosis is generally always made by excluding all other possibilities. In 6 of the cases in our series, there was definite evidence of syphilis, but in no case was there evidence of syphilis of the lung.

TABLE VII.—ASSOCIATED LUNG PATHOLOGY
FOUND AT AUTOPSY

	Number of cases
Abscess of lung, single, multiple	18
Atelectasis	7
Atelectasis with bronchiectasis	1
Bronchiectasis	1
Bronchitis	4
Emphysema	7
Empyema	3
Pleurisy	40
Fibrinous	2
Fibrous	24
Hemorrhagic	1
Pleural effusion and hydrothorax including 1 with pericardial effusion also	10
Serofibrinous	1
Serohemorrhagic	1
Suppurative	1
Pneumonia	23
Bronchopneumonia	13
Lobular	15
Lobar	1
Pneumoconiosis—anthracotic	2
Pneumoconiosis—moderate	5
Anthracosis—marked	1
Thrombosis, pulmonary	2
Tuberculosis, lung	4
Tuberculosis, hilum nodes	2

TABLE VIII.—CO-EXISTING DISEASES

Pneumoconiosis	7 (autopsy)
Pulmonary tuberculosis	7 (4 autopsy)
Syphilis	6 (positive serology)
Diabetes mellitus	2 (1 autopsy)
Hypernephroma	1 (autopsy)

Brain involvement. All adults having symptoms of involvement of the brain from any cause should have roentgen-rays made of the chest. Jaffe (14) found involvement of the brain in 19 cases in his series of 100 autopsied cases (in 23, brain was not examined). In our series of cases there was clinical or autopsy evidence of cranial metastases in 30 cases. In 4 of our cases there was no history referable to the chest. One of the 4 patients was operated elsewhere for brain tumor because of history of headaches, convulsions, and vomiting. No chest roentgen ray had been made. In an interesting report by Fried and Buckley (9) in 1930, central nervous system metastasis was found in 15 of 37 cases of bronchiogenic cancer. A diagnosis of brain tumor was made in 11 of the 15 cases and intracranial operations performed.

TREATMENT

Since many of the cases were far advanced upon admission to this hospital, irradiation was frequently the only possible choice of treatment. In some instances, this was contra-indicated because of patients' generally poor condition, leucopenia, et cetera.

TABLE IV—INVOLVEMENT AT AUTOPSY
(100 CASES)

Organ	No of cases	Organ	No of cases
Liver	41	Intestine	2
Adrenal	31	Pariosteum-skull clavicle (bone not invaded)	1
Contralateral lung	30	Stomach	1
Kidney	23	Thyroid	1
Pleura	20	Trachea	1
Heart or pericardium	19		
Bone*	15		
Brain†	11	Tracheobronchial	63
Pancreas	10	Retropertoneal	27
Spleen	6	Mesenteric	10
Diaphragm	6	Subacromial	0
Epiglottis or larynx	1	Cervical	6
Esophagus	1	Paracervical	6
		Axillary	5

*Only 18 of the 100 cases specifically examined for bone metastases.
†Only 14 of the 100 cases specifically examined for brain metastases because of restricted consent.

lesion. If an extensive pleural effusion is present additional films should be made after paracentesis.

HISTOLOGICAL AND PATHOLOGICAL FINDINGS

Often it is quite difficult properly to classify tumors of the lung in that the cellular structure varies a great deal and simulates other forms of malignancy. Samson, in a survey of 100 cases of bronchiogenic carcinoma in which complete autopsies were done, classified the cases as to cell type and found 51 per cent to be adenocarcinoma, 30 per cent squamous celled, and 19 per cent undifferentiated carcinoma. In Farrell's series of 50 cases, 23 were squamous celled carcinomas, 3 adenocarcinomas and 24 undifferentiated carcinomas. In a series of 100 cases specifically studied at Hines Hospital as to cell structure the histological classification was 36 squamous cell carcinomas, 35 adenocarcinomas, and 29 undifferentiated carcinomas.

The major bronchi near the tracheal bifurcation are lined by stratified epithelium. With the decrease in size of the bronchi from the tracheal bifurcation to the periphery of the lung there is an associated decrease in size of the epithelium, the cells of which become thinned out and less spindle shaped. At the ductus alveolaris the cells are cuboidal. The exact origin of the alveolar lining cells has not been determined. Lemon and Higgins (17) consider the alveolar lining cells to be histiocytes and mesenchymal in origin. Fried

TABLE V—BONES INVOLVED

Bone	Number of cases
Ribs	10
Vertebrae	5
Femur	3
Humerus	1
Ilium	1
Scull	1

(8) also believes that the alveolar cells are of mesenchymal origin and that "the epithelium of the bronchiole ends abruptly and is followed by the 'naked' walls of the air sacs."

The mucous glands in the wall of the bronchi apparently take their origin from the bronchial epithelium and their ducts are lined with ciliated cells which are continuous with the cells lining the lumen of the bronchus. Since the epithelial elements have the same embryological background all carcinomas of the lung probably arise from the lining cells of the bronchi. Samson has noted that the type of cellular structure in carcinomas of the bronchus depends upon the kind and degree of differentiation attained and not upon the level of origin in the respiratory tract. The cells of the less differentiated basal layer of the bronchus epithelium have the capacity to produce squamous epithelium, columnar epithelium, or undifferentiated round or spindle cells. The 3 types are squamous celled carcinoma, adenocarcinoma and undifferentiated carcinoma.

It is not definitely known just what pathologic processes bronchitis, bronchiectasis and other chronic diseases play in the etiology of carcinoma of the lung. The metaplastic changes which the lining cells undergo in these conditions are for a protective purpose rather than as a forerunner of carcinoma. Similarly when the endometrium is everted the cells become squamous as a protective measure. The great majority of primary carcinomas of the lung arise from the bronchial mucosa. A large percentage of the cases take origin from the epithelium of a bronchus of the first order.

The involvement of various organs as noted in 100 autopsied cases is given in Table IV.

In addition, in unautopsied cases there was clinical or x-ray evidence of brain metastases in 19 cases, of bone metastases in 14 cases, in 3 of metastases to skin—1 of the chest wall—1 of the abdominal wall—1 of the arm, thigh and abdominal wall, 17 of superficial glands, 3 of mediastinal glands, 1 of abdominal glands, 2 of metastases to opposite lung.

The frequency and location of bones involved in 15 autopsied cases having bone metastases are indicated in Table V.

TABLE VI—LOCATION OF CARCINOMA IN LUNG
(100 AUTOPSIED CASES)

Right side	No of cases	Left side	No of cases
First order	43	First order	30
Trachea, carina and first order	2	First order and carina	1
First and second order	1	Second order	2
First order and carina	2	Grossly diffuse	2
Second order	6	Origin undetermined	1
First, second and third orders	1		
Terminal bronchioles	3		
Grossly diffuse	4		
Origin undetermined	1		
Both sides			
First order and carina	1		
Summary	Right 63	Left 36	Both sides 1

Brunn in a study of 626 case reports, found the heart to be involved in 21 per cent of the cases and the suprarenals in 14 per cent

The location as finally determined from an examination of autopsied cases demonstrated a greater incidence of cancer in the right bronchus than the left. This corresponds to findings reported by others. The precise location (cases coming to autopsy) is given in Table VI.

Table VIII shows the co-existing diseases or conditions which were found in an analysis of these cases.

With regard to tuberculosis, we are of the opinion that tuberculosis in the presence of carcinoma is a coincidence. It is difficult to believe that either disease causes the formation of the other in the same person. Jaffe (14) found that 7 of his 100 autopsied carcinoma of the lung cases also had tuberculosis. However, there was no case of carcinoma formation from the metaplastic epithelium of an old tuberculous cavity. In many cases of early tuberculosis, the patients consult the physician because of a "generally run-down" feeling, loss of appetite and fatigue following slight exertion, whereas in cases of early carcinoma of the lung the most common symptoms are pain in the chest, cough, and dyspnea.

Syphilis of the lung is rare and quite difficult to diagnose, and such a diagnosis is generally always made by excluding all other possibilities. In 6 of the cases in our series, there was definite evidence of syphilis, but in no case was there evidence of syphilis of the lung.

TABLE VII—ASSOCIATED LUNG PATHOLOGY
FOUND AT AUTOPSY

	Number of cases
Abscess of lung, single, multiple	18
Atelectasis	7
Atelectasis with bronchiectasis	1
Bronchiectasis	1
Bronchitis	4
Emphysema	7
Empyema	3
Pleurisy	40
Fibrinous	2
Fibrous	24
Hemorrhagic	1
Pleural effusion and hydrothorax including 1 with pericardial effusion also	10
Serofibrinous	1
Serohemorrhagic	1
Suppurative	1
Pneumonia	20
Bronchopneumonia	13
Lobular	15
Lobar	1
Pneumoconiosis—anthracotic	2
Pneumoconiosis—moderate	5
Anthracosis—marked	1
Thrombosis, pulmonary	2
Tuberculosis, lung	4
Tuberculosis, hilum nodes	2

TABLE VIII.—CO-EXISTING DISEASES

Pneumoconiosis	7 (autopsy)
Pulmonary tuberculosis	7 (4 autopsy)
Syphilis	6 (positive serology)
Diabetes mellitus	2 (1 autopsy)
Hypernephroma	1 (autopsy)

Brain involvement. All adults having symptoms of involvement of the brain from any cause should have roentgen-rays made of the chest. Jaffe (14) found involvement of the brain in 19 cases in his series of 100 autopsied cases (in 23, brain was not examined). In our series of cases there was clinical or autopsy evidence of cranial metastases in 30 cases. In 4 of our cases there was no history referable to the chest. One of the 4 patients was operated elsewhere for brain tumor because of history of headaches, convulsions, and vomiting. No chest roentgen ray had been made. In an interesting report by Fried and Buckley (9) in 1930, central nervous system metastasis was found in 15 of 37 cases of bronchiogenic cancer. A diagnosis of brain tumor was made in 11 of the 15 cases and intracranial operations performed.

TREATMENT

Since many of the cases were far advanced upon admission to this hospital, irradiation was frequently the only possible choice of treatment. In some instances, this was contra-indicated because of patients' generally poor condition, leucopenia, et cetera.

Surgical extirpation of a centrally located growth must include removal of the entire lung and hilum, as well as the adjacent mediastinal lymph nodes. If the lesion is peripherally located, lobectomy may be sufficient.

Overholt has performed lobectomy upon 19 patients (2 carcinoma, 17 bronchiectasis) with 1 operative fatality, and pneumonectomy upon 11 patients (9 carcinoma, 2 suppuration) with 7 operative recoveries.

In 1933 Graham and Singer (13) stated that there were apparently 6 cases in the literature in which surgical procedures had been carried out the patients remaining either 1 year or more. Of this group 3 of the patients were operated upon by Sauerbruch, 1 by Churchill, 2 by Tudor Edwards, and 1 by Allen and Smith. Only limited portions of lung tissue had been removed. Graham and Singer reported 1 case which they described as being the first case in which the entire lung had been successfully removed at one stage.

In selected cases it is quite possible that the treatment of primary carcinoma of the bronchus through the bronchoscope with a combination of surgical diathermy and radon seeds may prove of value. Surgical diathermy in the treatment of carcinoma of the bronchus and trachea has been described by Kernan, Figs, Vinson and Bowing, Moersch and Bowing, and others.

PROGNOSIS

It is generally agreed that irradiation therapy will produce a palliative effect such as reduction of cough, lessening of pulmonary infections about the tumor, and general clinical improvement. The effect is merely palliative and temporary. However, the patient should receive it whenever possible.

Moersch and Bowing, in their cases in which no treatment was given, found the life expectancy after the microscopic examination had been made to be slightly more than 5 months.

Chandler and Potter found that in 59 patients with pulmonary cancer treated by roentgen ray the survival was 11 months following treatment. In 61 untreated cases the average duration of life was 6 months.

Vinson and Leddy reported 50 patients, who had received roentgen therapy, living and well from 15 months to 4 years after treatment.

In our series of patients treated by irradiation, 73 received roentgen therapy to the chest or mediastinal region. In 66 of these it was possible to estimate the duration of life. Others were omitted because of confusing factors such as co-

existing tuberculosis et cetera. The average duration of life in these 66 treated cases was 15 months. In a group of 48 cases in which the duration of life could be ascertained and who received no treatment other than symptomatic the average duration of life was 8.7 months. One history of particular interest was that of a patient who was admitted to the hospital in June 1935 with a history of symptoms of 2 years duration—50 pounds loss of weight, cough, dyspnea, fatigue, and substernal pain. Examination of tissue removed from the left main bronchus revealed adenocarcinoma. He received roentgen therapy in 1935, following which he regained his weight and has been practically symptom free up to the present time. It may be stated, however, that although he is symptom free except for a slight cough, the tumor has increased somewhat in size as shown by repeated roentgen ray examinations.

When the technique is perfected for lobectomy and pneumonectomy and more data are available, proper evaluation can then be placed upon these procedures. Probably the only way a complete cure can be obtained will be by one of these methods of surgery. Since so many of the cases are far advanced when seen, roentgen therapy offers a great deal to these patients in making their final days less burdensome and in many instances placing the patient in a more advantageous position socially and economically for a number of months.

SUMMARY

This report is based upon an analysis of the clinical and pathological findings presented by 164 patients having primary carcinoma of the bronchus in whom the diagnosis was established by postmortem examination (100 cases), by histological examination of tissue removed through the bronchoscope (21 cases), by other biopsy examinations (13 cases), or by clinical and roentgen ray evidence (30 cases). In each instance, the end result is known, constituting a 100 per cent follow up. This is the largest single series of cases to be reported.

There has been an increase in the incidence of primary carcinoma of the bronchus at this hospital. In 1931 the percentage of carcinomas of the bronchus as compared with all admissions made for carcinomas was 1.7, in 1936 the percentage was 6.5. It is quite possible that the increase is the result of improved methods of diagnosis rather than an actual increase in the incidence of the disease.

With regard to treatment, some surgical procedure will probably be the only means by which

a cure may be obtained. Since most of the cases generally seen are far advanced upon admission, irradiation is frequently the only choice. Irradiation therapy will cause a reduction of cough, lessening of pulmonary infections about the tumor, and general clinical improvement with prolongation of life

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SKELETAL DISTRACTION OF THE TIBIA

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IT SEEMS appropriate at the present time to stop and review the results of a procedure which is of foremost interest to the orthopedic profession, yet about which comparatively little has been written. On reviewing an early report of 2 cases published in 1931, the author finds his work to have been quite incomplete and the great changes that have occurred in technique of operation, construction of apparatus and methods for avoiding complications have impressed him with the necessity of a frank review. The history of leg lengthening has been described but will bear a short summation together with additional reference to the work of a French surgeon hitherto unnoted.

Codivilla in 1905 advocated skeletal traction, the first step forward in this work, but failed to note that the stress of force must not cross a joint and that it must be gradually applied over a period of time.

Beginning in 1908, Magnuson amplified previous work. Attempts to lengthen the tibia by skin traction have been tried and discarded as late as 1918. Putti in 1912 advocated direct skeletal traction on either end of the divided bone which is the principle I have called distraction, without the passage of the pins completely through the extremity. Other workers have had difficulty in preventing pins in the apparatus from slipping. Abbott of St. Louis in 1927 passed the distracting pins completely through the extremity, obviating the danger invited by Putti's method. Numerous other methods have been devised and descriptions of some of them published but all of those successfully used have embodied the principles of distraction: transfixation of pins and gradual lengthening.

Following publication of preliminary work with skeletal distraction in 1931, I received a communication from Dr. O. Lambret of Lille, France in which he referred to a presentation in 1911 before the Society of Surgery of Paris published in the *Presse Médicale* in July of that year, which embraced the principles of distraction and transfixation. Included was a two pin apparatus for use on fracture cases. In 1916 this was again published in *Grand Traité de Chirurgie* together with illustrations of the apparatus and roentgenograms of cases.

Priority for the first application of real skeletal distraction pins transfixation must therefore go to Dr. Lambret who used it in fractures only. Its development in actual lengthening of an extremity has occurred since that time.

The principles involved in successful lengthening of a bone of an extremity are (1), skeletal distraction requiring the application of positive skeletal tractive force to either end of a divided bone without the interposition of a joint, (2), complete transfixation of pins with lengthening force applied on both ends of the pins, (3), gradual lengthening over a period of time, (4), maintenance of skeletal distraction for a sufficient period of time following lengthening for solid union to occur.

Apparatus. As late as 1929, a single pin in the upper tibia and in the lower tibia was being used, together with a supporting splint or frame to maintain balance of the foot and lower fragment. Difficulty of maintaining alignment and development of a pressure sore over the os calcis on an early case forced me to the use of an additional pin through the os calcis allowing direct skeletal control of the foot and lower fragment. Even then sufficient control of alignment was not easily maintained so that in 1930, five pins in all were being used, two in the upper tibial fragment, two in the lower tibial fragment, and a free pin through the os calcis. In addition, a drill guide was devised for placing these pins accurately in alignment and in 1934 additional sleeves were made for the guide for the placement of Kirschner wires. Since that time, wire has been used in children and pins have been employed in older youths and young adults. Apparatus showing the use of both wires and pins is appended (Fig. 1). The apparatus consists of two side bars with ratchet operated by keys, a drill guide and pins or wires. When set up, the side bars are placed upon the ends of the four wires or pins extending through the extremity, and locked to them by set screws. When locked to the pins in this way, there is absolute rigidity and in the case of Kirschner wire, the same rigidity is present as soon as the spreaders have been fastened on the wires. The spreaders themselves act as a suspending apparatus whereby the extremity can be slung to a Balkan frame. When pins are used the four corners of the apparatus are connected

by wire loops to a single supporting wire for overhead suspension. The pin or wire through the os calcis provides not only for support of the foot but maintains dorsiflexion thereof. The supporting cable for the os calcis pin is kept fastened at an angle toward the head end of the Balkan frame, a padded rest being placed between the metatarsal area of the foot and the supporting cables or Kirschner spreader. The side arms are provided with holes at one-half inch intervals for a sufficient portion of their length so that they will accurately fit onto wires or pins drilled through the guide and any length of tibia can be accommodated. Lateral or anteroposterior angulation of fragments is under the complete control of the surgeon. Lateral angulation can be secured or corrected by rolling out either side arm separately (Fig. 2). Lateral displacement can be overcome by sliding either fragment sideways on the pins or wires and anteroposterior angulation can be secured or corrected in either fragment by the use of levers placed between the proximal or distal wires and drawn down and fastened to the side arms. All these corrections of displacement have been easily and safely overcome in actual cases by the means given without anesthesia and during the actual process of lengthening.

Operative procedure has changed in the last 7 years, both as regards the main procedures and as to mechanical details developed to prevent complications. If followed through carefully, though quite extensive, it progresses rapidly and smoothly. A tourniquet is always used. It is perhaps best to tabulate the procedures.

1. *Incision.* Achilles tendon lengthening is done by inverted "L" incision to maintain continuity of tendon tissue. If further dorsiflexion of the foot is needed, the deep layer of the crural fascia underneath is divided vertically. Posterior capsulotomy of the ankle itself has not been necessary.

2. *Insertion of pins.* Four pins or wires are inserted through the tibia by means of a drill guide. Inserting these pins, two should go through the upper metaphysis and two through the lower, the pins being separated 1 inch. The skin should be retracted as firmly as possible toward the center of the leg to allow for stretching required during later lengthening (Fig. 3). As the skin has been thus retracted toward the center of the leg, the drill guide is placed firmly against the skin with the templet of the guide parallel with the sagittal plane of the tibia and not with the leg. The guides themselves should be pushed through the templet until they are in contact with the skin. Pressure then applied will mark the skin at the

point of contact with the guides. Tiny stab incisions can be made through the skin at the marks left by the guides. It is well to note that the guide should be always held on the inner and not the outer side of the leg. The guide is again placed on the leg with the skin retracted toward its center, and a drill hole is placed through the lower guide. A pin placed through this guide and hole can be forced through the anterior muscle bundle of the leg and a nick in the skin is made over the end of the pin thus allowing it to emerge externally. When this pin is in place, the apparatus will be well stabilized for setting the other pins. The second of the distal pins can be placed in similar fashion. It is extremely important when placing the third pin of the series which is next to the top, that the drill guide be sprung forward one-fourth inch on the lower two pins before the hole is drilled (Fig. 4). This third hole is drilled but no pin placed through it until after the fourth pin has been drilled for, put in position, and the drill guide removed. Then the third pin can be driven into place and the fifth pin placed through the os calcis. In the use of Kirschner wire, the same procedure is followed, the wires being introduced directly without drill holes. The reason for the offset third pin is to provide for forcible maintenance of contact of the tibial fragments following osteotomy, thus preventing anterior bowing. Dressings wrung out of Dakin's solution can be placed over the ends of the pins before the next step is taken.

3. *Osteotomy of the tibia.* Through an anteromedial incision, the tibial shaft is exposed in the central area and by motor saw, its cortex is cut through near the internal border and on the lateral surface. These saw cuts are joined below by a transverse cut in front and above by means of the Gigli saw behind. This leaves a tongue above and groove below with the tibia slanted slightly on the pins so that lengthening causes increased forceful apposition of fragments. The fibula is easily reached intramuscularly through the lateral tibial periosteum and divided by osteotome. Whether single or double osteotomy was done (Fig. 7) has seemed to make no difference in the lengthening result, and the level of the osteotomy (Fig. 9) is unimportant. Through the same incision, division of the leg fascias can be done but in none of the cases subsequently reported has it been done. In view of results it seems unnecessary.

4. *Placement of side arms.* The side arms of the apparatus can now be placed on the four tibial pins and extended to tautness by the keys. By sliding the lower tibial fragment, lateral displacement can be overcome (Fig. 2d). If slight

lateral angulation is present, further extension of one side arm will overcome it (Fig 2c). Antero-posterior displacement is impossible and the fragments will be found very firmly held in apposition due to the offset third pin described. When perfect alignment has been secured, one can proceed with the closure.

5 Wound closure Wound closure should be with interrupted silk, Stewart, or submarine suture and should include merely the skin and half the fatty subcutaneous tissue. Not only is it not necessary to close the periosteal layer, but it will be found to be impossible to do so. No deep sutures should be used.

6 Dressings Dressings wrung out in Dakin's solution should be very lightly put in place, not forgetting to dress the tendo achillis incision as well as that of the osteotomy. The pin dressings have already been applied.

7 Suspension of apparatus The patient is returned to bed and the apparatus suspended from an overhead frame. At first counterbalancing weights were used but it has been found that the patients are more comfortable and the apparatus more stable with fixed suspension, all support being through wires permanently fastened to the overhead frame at a definite level without pulleys or counterweights. A sling of muslin fastened to the side arm may be placed under the calf to give a sensation of support and relieve tension on the suture line. This support should not be too great or it will cause anterior bowing of the fragments (Fig 5).

8 Suture removal Removal of sutures should be done on the seventh day, great care being taken to remove the dressing only over the suture area of the tibia and tendo achillis without disturbing the dressings covering the emergence of the pins from the leg. This is generally easy to accomplish since the dressings were placed on the pins before actual lengthening operation on the tibia was begun.

9 Lengthening process Lengthening should not be begun until 2 or 3 days after removal of sutures when all dressings are off and the actual incisions and the whole leg and foot are open to inspection except the emergence of pin holes. If any complication such as hematoma or infection develops during the course of lengthening, no further attempt to secure extension should be made until the hematoma has been evacuated and healed or other complication has been overcome. In the usual case incision healing will be present by 7 days, suture holes healed by the ninth or tenth day and lengthening can safely proceed thereafter at the rate of one tenth of an

inch every other day or slightly faster. In children, union will be occurring by the time lengthening is secured but in adolescents and adults no fear of union occurring to stop lengthening need arise. In fact, it is delayed in adolescents and fails to occur without additional bone graft in adults. Plenty of time is allowed therefore, in these latter cases for overcoming complications and still securing lengthening.

10 Fixation When the desired or maximum amount of lengthening has been secured the apparatus and limb are removed from suspension. The dressing on one side of the os calcis pin is pulled off the pin, iodine and alcohol applied at the point of passage through the skin and the pin is cut off with sterile rivet shears at a point which lies beneath the dressing and has remained sterile throughout the lengthening. The remainder of the pin can be pulled through the os calcis and iodine injected through the pinhole without anesthesia or pain to the patient. The pinholes are uniformly without sensory nerve supply. Dressings are placed over the os calcis pinholes. A plaster cast is applied inside the side arms firmly incorporating the tibial pins and their dressings in plaster. Following hardening of the cast, the pins are cut between the cast and side arms with rivet shears, and the ends of the pins remaining are covered with another layer of plaster bandage. When wires are used clips on the wire ends are included in the cast to prevent the wires from bowing. The plaster boot should extend up the thigh to give a sense of stability to the patient. The cast can be cut and wedged to get perfect alignment, and reinforced at the cut with a few layers of plaster to maintain correction. Actual contact of fragments is positively maintained by the four pins remaining in the tibia. The patient can now become ambulatory on crutches.

11 Osteoplasty Osteoplasty of the upper defect is generally required if the patient is over 12 years of age and always required if the patient is an adult. Graft of the lower defect has not proved necessary due to the large mass of shaft left there at time of operation (Fig 7). By the time lengthening is complete roentgenograms will give a definite knowledge as to whether bone graft to fill the upper defect in the tibia behind the tongue is necessary. There are several reasons for having the tongue cut above, but the most important is that it places the defect which is largest toward the upper part of the tibia where osteogenesis is best. If osteogenesis has failed to progress by the time lengthening is complete, there is no reason for delay in grafting this upper defect. It can be done within a week of the appli-

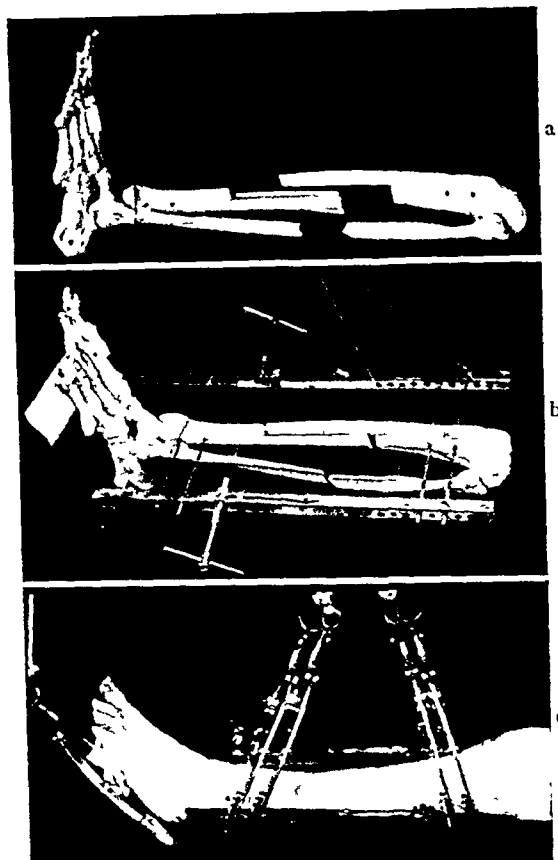


Fig 1 Lengthening apparatus as applied with three-sixteenths inch drill steel pins and Kirschner wires. Note fifth pin through the os calcis and support of padded bar under metatarsals. Tongue and groove osteotomy of the tibia shown, leaving larger portion of tibia below which regeneration is slower. Single osteotomy of fibula present. The offset position of the third pin hole causing forced apposition of fragments can be seen. Note distance of pin holes from joint surfaces and osteotomy site. Plenty of room left for dressing and exposing osteotomy wound without changing pin dressings or exposing points of pin entrance.

cation of the supporting cast through a window in the cast, bone being taken from the other tibia. Strips of bone are inserted in the defect abutting the lengthened fragment ends, thus preventing telescoping and loss of length. Following placement of the graft, the cast is closed again and remains in place without further disturbance until solid union has occurred.

APPLICATION OF PROCEDURE

Twenty-four tibial lengthenings have been completed in the past 8 years (Table I). These

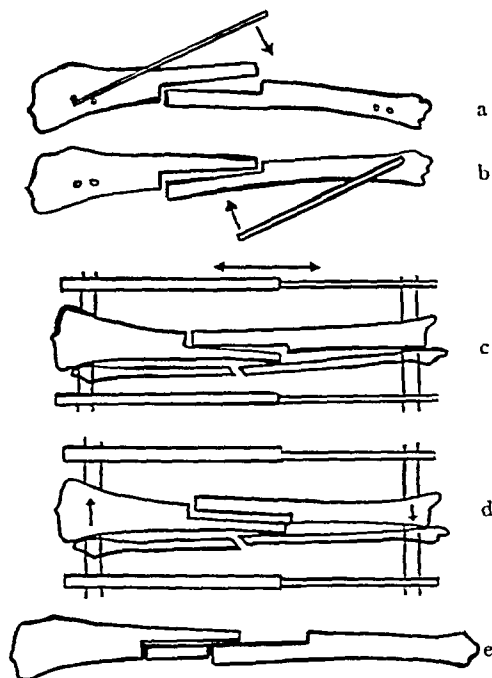


Fig 2 a and b, Diagrammatic sketch to show method of correcting anterior or posterior angulation by use of levers placed between the upper and lower wires. The action of the lever in a is the same as that caused by the offset third pin at time of operation. c, Correction of lateral angulation by lengthening of one sidearm. When wires are used they go through the distal fibula. When pins are used they are placed anterior to it. d, Method of correcting lateral displacement by sliding fragments sideways on wires. e, Strips of cortex (represented as a block) have been removed from the other tibia and inserted behind the tongue in the upper defect, thus preventing loss of length and hastening osteogenesis by acting as grafts. This must be used on adults.

have been separated into three classes for study, as they vary considerably regarding the ease of lengthening and period required for the end-result secured. Six of the cases have had shortening following poliomyelitis, 13 were short normal legs, and 5 were recent fractures. By short normal legs I mean legs in which there was no pathological condition except for the shortening itself and no muscular paralysis. They include 4 cases of malunion of fracture of many months' duration, 1 due to tuberculosis of the hip, 1 due to shortening of the thigh from osteitis fibrosa cystica of the femur, 2 following early closure of the epiphyseal lines of the tibia following injury, 2 resulting from old congenital dislocation of the hip, and 3 due to dyschondroplasia. These three lengthenings for dyschondroplasia occurred in 2 patients, 1 of whose legs was lengthened and later reoperated



Fig 3 The skin is retracted toward the center of the leg to allow for the stretching it will receive as the leg is lengthened. The second pin has been drilled through to the skin and the skin is being stretched over the end of the leg before it is nicked by the scalpel for passage of the pin.

on and lengthened further. She was a chondrodystrophic dwarf with a very short femur and a total of $3\frac{1}{4}$ inches was secured by the two lengthenings. The other had a dyschondroplasia of the whole lower extremity, evenly balanced between the tibia and femur. The third classification of cases was recent fractures and of these there were 5. All were seen within 1 to 4 weeks following fracture and were easily lengthened and length maintained.

Five of the 24 cases have been done too recently to report (within the last 18 months) so that 19 remain for study. Of the cases indicated for study, the most recent was done 28 months ago and the first $8\frac{1}{2}$ years ago.

Gain in length (Table II). The greatest gain in length secured by one operation was $1\frac{1}{2}$ inches in a case of poliomyelitis (Fig 9) the least $1\frac{1}{4}$ inches. In every case, the gain secured was the

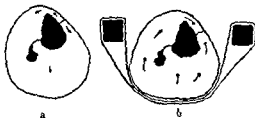


Fig 5 a The result of suspension of the leg by pins is a thinning of the scar due to pull on the tissues over the tibia by the sagging calf. b Support of the calf in a sling passed over the side arms releases the pull on the suture line resulting in quicker healing both of the skin incision and of the bony structures with a thicker pad of soft tissues over the tibia at completion of the case.

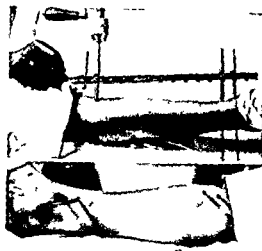


Fig 4 Above the drill guide is shown being sprung forward for the placing of the offset third pin. This will cause forcible apposition of fragments later. Pins or wires are spaced at one inch intervals. Below, all five pins are in place. Note the offset third pin from the bottom in the tibia which maintains forcible contact of tongue with groove and prevents anterior bowing.

total amount required to balance the patient. Children were measured every 3 months for 9 months to 1 year to estimate the rate of shortening.

Lengthening was then planned to care for the estimated amount of shortening at time of cessation of epiphyseal growth. No child below 8 years of age was or should be operated upon. Younger than this we could not satisfactorily estimate the rate of growth. All the adult patients were examined before operation placing a raised shoe or block under the foot and their gait and posture noted to determine accurately the amount of lengthening which would be optimal (Fig 6). Frequently a complete lengthening to match the good leg would not have given a good general correction to their posture as fixed.

TABLE I — DISTRIBUTION OF CASES

	Cases
Poliomyelitis	6
Short normal	13
Malunion fracture	4
Tuberculosis of hip	1
Osteitis fibrosa cystica femur	1
Early closure epiphysis	2
Dislocation of hip	2
Dyschondroplasia	3
Acute fracture	5

Total number tibial lengthenings

TABLE II—SUMMARY OF CASES

	Case No	Gain inches	Speed inches per diem	Stat gain inches	Pain days post-operative	Pins out months post-operative	Follow up years post-operative	Complicating factors
Acute fractures	1	2				2	2	Fractured rib, empyema perforated lung died
	2	1½	Immediate	Full	Relieved	2	6½	Graft
	3	1½				1½	3¼	Compound
	4	1½				2	6	Graft
	5	1¼				1½	3	None
Suppurative knee	6	2¼	¼	¼	4	3	7½	Graft
Fracture	7	2	½	¾	1	2	8½	Graft
Fracture	8	1½	1½	1½	1	1½	4	Old age
Chondroplasia	9	1¼	½	¾	2	1½	6	Infected
Poliomyelitis	10	3½	¼	¼	2	3	4	Delayed union
Fracture	11	2	2	2	1	1½	6½	None
Poliomyelitis	12	1¾	¼	¼	4	4	5½	None
Poliomyelitis	13	2	¼	¼	5	1½	6½	Graft
Closed epiphysis	14	2½	½	½	4	4	5½	None
Poliomyelitis	15	1½	¼	¼	10	4½	6½	Infected
Suppurative hip	16	2½	½	½	16	5	5½	Infected
Poliomyelitis	17	2	¼	¾	31	16	4½	Delayed union
Tuberculosis of hip	18	2	¼	¼	2	3	3½	None
Fracture	19	1½	1½	1½	2	2	5½	None

changes had already taken place in the spine and pelvis to accommodate some of the shortening present in the leg. For this reason, adult short legs were not always lengthened to match the long leg but merely enough to give them the best possible stance and gait as determined before operation. In all cases but 1, the desired amount of lengthening was secured. This case was the chondrodystrophic dwarf in whom it took two separate lengthenings, 3½ years apart, to overcome enough of the shortening to give her a fair stance and gait. In none of the cases did the lengthening secured prove too much and throw the patient out of balance. The speed of lengthening is also shown in Table II but certain points which are very important might not easily be seen. The recent fractures permitted immediate attainment of full

Fig 6 a, The block used here is not enough to compensate for full amount of shortening. Fixed spine and pelvic changes were present which made this raise of the leg comfortable and helpful. Full correction by a longer block caused the patient's trunk to shift to the left and gave her a severe posture defect. b, This patient has perfect balance resulting from full correction of shortening by a block under heel before operation, proof that fixed spine and pelvic changes do not contra-indicate full lengthening of the short extremity in this case

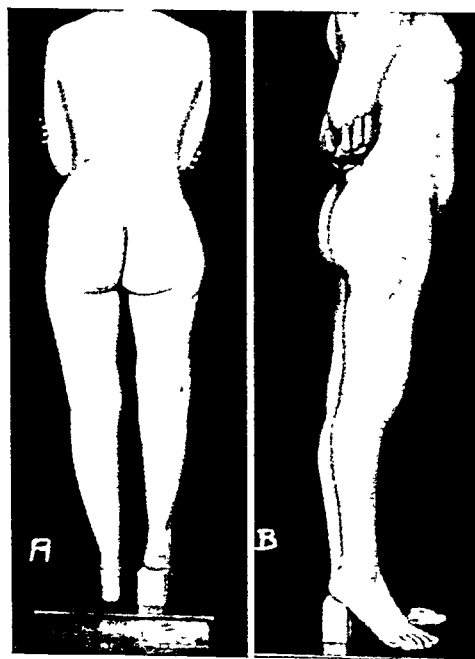


Fig. 6.



Fig 7 Young adult $5\frac{1}{2}$ year result Double osteotomy of fibula used Upper site healed and all lengthening was gained through lower Single osteotomy of tibia preferable Crafting of tibial defect done both by onlay and interposed bone Pin holes show complete closure Place

ing pins further posteriorly would have prevented slight amount of anterior bowing and this could have been removed by wedging the post lengthening cast Note small amount of immediate gain in lengthening at the time of operation

reposition (Fig 10) Three of the four malunion fractures though solidly united and many months old, permitted full gain of length within an hour on the operating table one of them 2 inches (Fig 11) and 2 others $1\frac{1}{2}$ inches each The fourth malunion fracture, though only 5 months old was only lengthened a twelfth of an

inch a day¹ All the other short normal legs were lengthened over a period of time It will be noted that in 2 of them which were lengthened too rapidly (at the rate of one fourth and one sixth inch a day respectively) the incisions broke down

¹F m Skeletal d fract n, description of apparatus David M B W rth Surg Gynec & Obst 1931 32 893-897

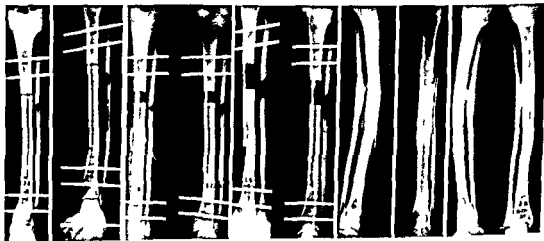


Fig 8 Young adult, poliomyelitis $6\frac{1}{2}$ year result High osteotomy of fibula present (Fig 7) Excellent alignment through lengthening with final bowing due to not holding in plaster long enough for complete ossification of defect to prevent pull of calf from bending soft plastic area

in tibia Pin holes healed Slight eversion of ankle by x ray in last picture not clinically appreciable Bowing much less pronounced physically than by x ray Note small amount of immediate gain in lengthening at the time of operation

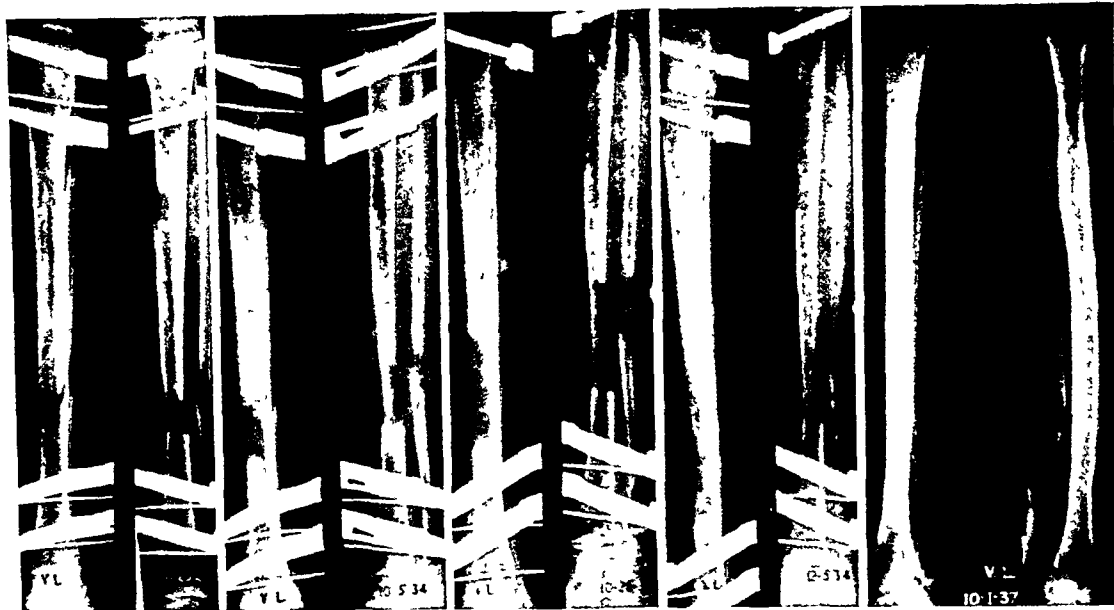


Fig 9 Adolescent poliomyelitis, 3 year result Lengthening of $3\frac{1}{2}$ inches completed in 14 months Lumbar sympathetic ganglionectomy to increase blood supply of blue paralytic leg, subtalar arthrodesis, posterior ankle

block and knee fusion all preceded lengthening Note angulation corrected at time of cast application Pin holes healed, single fibular osteotomy, reformed marrow cavity. Rather marked ankle eversion not appreciable clinically.

Only one other infection in the series occurred and this was due to the use of deep sutures and vaseline gauze dressing. All three healed, united, and maintained the length gained. They have shown no recurrence of infection during the past 4 years. An average speed of one-tenth of an inch a day during the complete postoperative period of lengthening is within safe limits and a greater speed is dangerous. The immediate gain in lengthening at time of operation, except in fractures, is about one-fourth of an inch, and it is not possible to secure more than three-eighths of an inch in short normal legs or poliomyelitic legs, even with very forcible extension of the apparatus (Fig 8).

Postoperative pain has been considered a reason for avoiding leg lengthening, but as can be seen from Table II, it was not persistent except in 3 cases. Two of these 3 cases were the ones in which lengthening was started immediately after operation without waiting for wound healing, and continued at too rapid a rate, namely more than one-sixth of an inch a day. The third case was a young woman who complained continuously, until after application of her cast following completion of the lengthening. The length of follow-up on all cases is included in the same table for convenience.

Numerous questions have arisen regarding the pins placed through the tibia and some of these questions can now be definitely answered. In 1 case, the pins remained in position without infection or change of dressing for 16 months. They were still tight at the end of that time. The average length of maintenance *in situ* was between 3 and 5 months. In 16 of the 19 cases the pins were still firmly in place at time of removal, and without apparent bony absorption surrounding them. In only 3 of the cases was there infection of pinholes. These 3 cases included the two which were run out too rapidly, and the one in which the wound broke down due to deep sutures. In all other cases, pinholes were dry and without discharge. All pinholes healed within 3 weeks except in 2 of the infected cases mentioned. One of these required 3 months and the other $4\frac{1}{2}$ months to heal. The holes in the tibia caused by the pins filled in completely in 8 cases, almost completely in 2 others, and partially in 1 other. In all remaining cases the hole which persisted became surrounded with cortical bone with rearrangement of the internal structure to assume new lines of force (Fig. 12). In 1 of the cases lengthening was too rapid and a sequestrum formed which was easily removed, healing took place subsequently and left a leg with full regeneration of the tibia



Fig 10 Comminuted acute fracture reduced with leg lengthening apparatus closed method and placed in immediate cast including the pins

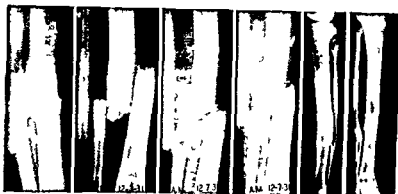


Fig 11 Young adult 6 year result Malunion fracture of 6 months duration reduced in 1 hour with apparatus (open operation) wide stripping of the periosteum osteotomy of callus area great extensive force and manipulation of fragments and soft tissue with distractive force acting Note pin holes still not completely closed



Fig 12 Necrosis of the wound resulted in this case from the use of deep sutures and vaseline dressing One and one half inch gain maintained Healing of skin and bone defect was rapid and the same leg was lengthened another 2 inches within the past year without complication Note cortical bone formation about lower pin hole and realigned lines of force in surrounding bone



Fig 13 Following union of lengthening, this boy's tibia grew 6 inches in length in 4 years. Note that slight posterior bowing results in no defect. This is definite proof that operative lengthening does not stop epiphyseal growth.

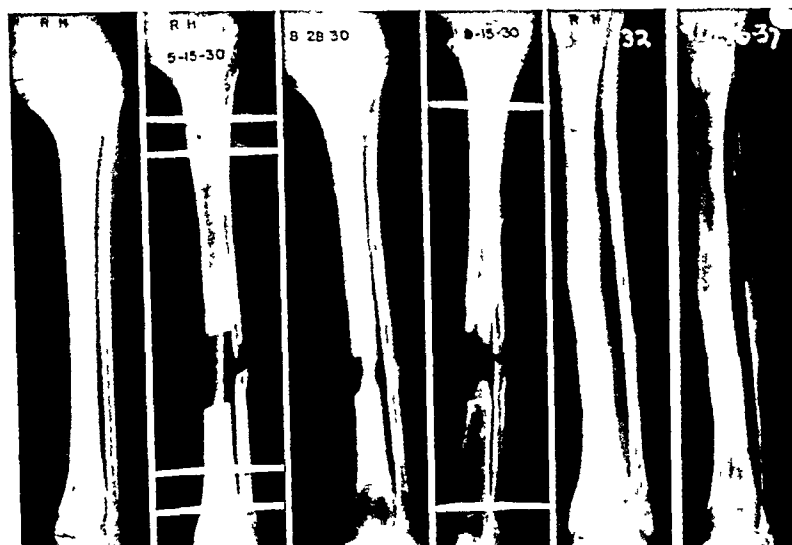


Fig 14 Young adult, 7½ year result. Shortening due to suppurative arthritis of the knee at 1 year of age. This shows result of placing the tongue of the lengthening below. Delayed regeneration, fracture and absorption occurred. Successful relengthening to 2 inches and defect grafted.

and the original amount of length secured. Four cases required grafting following the lengthening, 3 in old malunion fractures, and 1 a young woman of 18 years with a short normal tibia (Fig 14). Growth of the legs continued in every case in which the patient was in the growing period. One

child's tibia grew 6 inches in 4 years following complete union of the lengthening (Fig. 13). No epiphyseal cartilage damage could be demonstrated in any instance. There was definite clinical evidence of damage to joint structures as follows: 6 ankles showed a loss of motion varying from



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TABLE III.—DISABILITY

	Total Weeks	Partial Months	Retarding Factors
Poliomyelitis			
4 uncomplicated	6-12	4-16	Age—length gained
1 complicated	12	33	Infection
Short normals			
4 uncomplicated	2-12	5-15	Age
5 complicated	6-8	4-26	Bone graft—Infection
Acute fractures			
2 simple	1	4-5	Communion
3 compound	1	4-15	Infection—Nonunion

in lengthening due to intact fascia was noted. A drain was used on one of the early cases, but it is believed better to take the risk of an occasional hematoma. The optimal dressing is one wrung out of Dakin's solution and was found to leave a cleaner incision than either dry or vaseline gauze.

The period of disability is shown in Table III. The greatest factor extending disability, appears to be the age of the patient. Children unite very fast and can be completely ambulatory in 4 to 7 months. Adults require 12 to 16 months. One infected case required 33 months. A safe average would be a year. Infection delayed the end-result in each of 3 cases tremendously.

Complications are shown in Table IV. There was infection in 3 cases, 2 following rapid lengthening and 1 from use of deep sutures and macerations by vaseline gauze dressing. I believe that they can be avoided by slow lengthening; the use of silk sutures, avoidance of locked stitch, deep sutures, and drains, and the use of a dressing wrung out in Dakin's solution. Delayed reossification occurred three times, and in each instance was directly attributable to the age of the patient, the length of the gap left in the tibia or the small size of the upper tibial tongue (Fig 8). Nonunion which required grafting occurred four times and was the result of compounding or comminution of previous fracture, failure of sufficient continuity of bone contact, or age of patient. All were grafted successfully. Anterior bowing occurred 5 times in the early cases of the series. It has not occurred since the offset third pin has been used and the cast wedged, nor has it been enough to embarrass the operator or patient. It rarely occurred during lengthening but generally afterward when skeletal traction had been removed, and the pull of the muscles bowed the soft new bone (Fig 15). Moderate eversion of the foot at the ankle occurred 6 times. In only 1 case was it of sufficient extent either to come to the patient's attention or to require correction. In

TABLE IV.—COMPLICATIONS OF LENGTHENING

Complication	Number	Causal factors
Infections	3	Too rapid lengthening, catgut sutures, locked stitch, vaseline dressing, deep sutures used
Slow re-ossification	3	Age of patient, length gained
Bone graft required	4	Age of patient, compound fracture, comminuted fracture, failure of continuity
Anterior bowing	5	Early cast removal, third pin not offset, first cast not wedged
Ankle eversion	6	Early fibular union, incomplete osteotomy fibula
Hematoma	2	Unknown

that case a later osteotomy of the tibia and fibula corrected the deformity. In 2 instances the eversion was spontaneously corrected by epiphyseal growth in less than 3 years. Hematomas have occurred twice, and in each instance have been evacuated successfully without infection and without preventing completion of lengthening. It is imperative to await complete healing of a hematoma. Reoperation is always possible at a later date, provided one has not rashly proceeded with the lengthening and lost the extremity through infection. Cavus foot and hammer toes gradually develop during lengthening, due to tautness of flexor and extensor tendons. In no case did they persist. The muscles gradually stretch after lengthening is complete and the foot and toes straighten out. A new marrow cavity developed in every case, and several times was present as early as 4 to 6 months after operation. There were no cases of footdrop, either temporary or permanent, nor evidence in any case of peroneal or tibial nerve irritation or paralysis. No extremity showed decreased blood supply due to stretching of the blood vessels.

There were 46 other operations performed on these 24 patients not including the lengthening operations and grafts of the lengthened site. Most of these other operations were on poliomyelitis patients. Their reconstruction is always more complicated than the ordinary case. In 2 cases lumbar sympathetic ganglionectomy was done so as to secure sufficient circulation for lengthening. The child who gained 6 inches in length from growth, following tibial lengthening, was not one of these, therefore his growth could not be attributed to that procedure. Other reconstructive operations on poliomyelitic cases included one osteotomy of the tibia and four osteotomies of



Fig 15 Two and one half year result in adolescent with shortening due to tuberculous hip. Slight bowing which occurred after removal of plaster due to the pull of the calf on soft bone at the site of lengthening. Note that the wires went through the distal fibula as well as tibia resulting in drawing the fibular head to a lower position than normal. No clinical embarrassment from this.

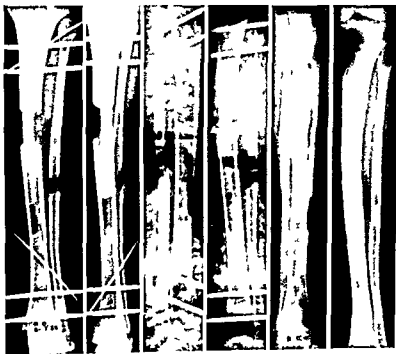


Fig 16 R O 30 year old female lengthening of 1 1/2 inches completely solid walking in 7 months. Speed of recovery due to immediate graft of upper tibial defect following lengthening. Shelf operation for congenital dislocation of hip preceded lengthening and subastragaloid arthrodesis for associated foot deformities followed immediately after lengthening to complete the case.

one tenth to one fourth. Two knees showed a loss of one eighth, and one third, the range of normal flexion respectively. No relaxation of joints could be demonstrated due to this procedure. There were no cases of shock and no

deaths. It was found that the length of time required for union was shorter when the tongue of the tibial osteotomy on the upper fragment was made fairly large. The fascia of the leg was not divided in any case. No complication or difficulty

OPERABILITY IN CANCER OF THE RECTUM

T E JONES, M D, F A C S, Cleveland, Ohio

EVIDENCE of the fact that operability is a more or less vague term is apparent when one reads the literature and finds that operability statistics in cancer of the rectum are at great variance, being quoted from 25 to 70 per cent. Many of these statistics are presented by able surgeons of equal capabilities and the only way the wide difference can be explained is that figures are arrived at by entirely different methods of analyzing groups of cases. It seems to me that a simple method of computing our statistics could be used, so that various series of cases could be compared on an equal basis. With this object in view, a critical analysis of one hundred consecutive cases of cancer of the rectum has been made, listing exactly what happened in each case. For instance, a patient is advised to have an operation and promises to go to the hospital but does not return. Such cases make up a certain percentage of everyone's total series, but the question arises: Where should this case be classified? One writer will not include the case while another will add it in his total. When such cases amount to 10 per cent of the total, it is easy to see that a wide variation in figures will result, but this would not be true if all data were summarized in the same manner. In the table below is listed exactly what happened to one hundred consecutive patients with primary untreated carcinomas of the rectum as they appeared for examination during a period ending July 1, 1937.

TABLE I

A Patients examined	100
B Radical operation advised, did not return	10
Balance	90
C Operation not advised, too far advanced.	11
Palliative procedure advised	9
D Operated upon for cure	20
E Inoperable at exploration	70
Liver involved	13
Local fixation	10
F Operation completed	3
	57

It is evident that 10 patients (B in Table I) whose condition was considered clinically operable did not return for various reasons, viz., distance away from home, objection to colostomy, or desiring another hospital or surgeon, therefore,

From the Cleveland Clinic.

operability should be computed on a basis of the figure 90. I think this is fair because, if exploration were done, it is quite likely that in at least 8 cases the operation would have been completed, judging from the number of cases with complete operation as shown in the table.

An analysis of the inoperable group of 20 cases (C in Table I) is given in Table II.

TABLE II — ANALYSIS OF INOPERABLE CASES

No operation was advised in 11 cases because	Cases
a Palpable liver metastases	3
b Extensive local invasion	1
c Bladder perforation and age	2
d Fixation in patient aged 71	1
e Age 75, condition poor	2
f Cachexia and moribund	1
	11

While I am a staunch advocate of colostomy, there are certain patients for whom it is not indicated and, in this group of 11 patients, I did not think it would add materially to their comfort.

Palliative operations were advised in 9 cases for the following reasons:

	Cases
Advanced lesions, ages over 70, condition poor	5
Fixation and pelvic metastases	4
	9

Palliative operations consisted generally in colostomy with or without radiation and, in some cases, radiation or coagulation without colostomy. The reasons for these procedures varied: (1) obstruction, (2) liver involvement, extreme age, etc.

In these two groups, then, which comprise 20 cases, the condition was considered inoperable; on a basis of 90 cases, that is 22 per cent.

There remains a group of 70 cases which we considered to be clinically operable or at least deserved exploration, even though many were borderline cases from the standpoint of fixation. Based on the figure of 90, this can be construed as an operability figure of 78 per cent. However, it will be seen that the growth in 13 of these 70 patients (D in Table I) was found at exploration to be inoperable due to liver metastases (10 cases) and local fixation (3 cases). In this group of 13 cases, 8 patients had colostomy and 5 did not, because it was estimated that death would

the femur for genu valgus, genu varus, or slight knee flexion defects, 7 subtalar arthrodeses, 1 posterior ankle block, 5 tarsal sections, 2 knee fusions, 5 transplantations of the extensor tendons to the dorsum of the foot, and 2 spine fusions for paralytic scoliosis. Besides these, the following reconstructive operations of other non poliomyelitic cases were necessary prior to lengthening of the tibia. One bone graft was done for non union fracture. Three operations for congenital dislocation of the hip had been done elsewhere on one patient and a shelf operation was done in our clinic to stabilize the extremity. A tuberculous hip had four attempts at fusion before solid union

was secured. Eight skin grafts were performed in 4 traumatic cases before lengthening, to remove adherent scar and cover the tibia. A laminectomy fusion was done in a case of chondrodystrophic dwarf with hemivertebra, angulation of the cord and bladder symptoms.

In concluding there have been no mortalities, no loss of extremities, no failure to gain or maintain length, no non union, and no unhealed or disabled cases. To take a series of such cases and carry them through successfully entails strict adherence to detail and technique, and personal attention to every step of the procedure through out the patient's operation and convalescence.

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intervene before obstruction occurred. Therefore based on the figure of 90, there were 57 completed operations, or 63 per cent, whereas computation on the basis of the 70 explored cases would give an operability figure of 80 per cent. Furthermore, it will be seen that excluding the cases in which the liver was involved, we completed the operation as far as the local lesion was concerned in 56 of 60 cases, or 93 per cent.

It is apparent then why operability figures vary. For purposes of comparison therefore, operability figures should be reported both in relation to the number of cases seen and those in which operation is advised and in relation to the cases explored. These figures bear out the fairness of eliminating the 10 patients whose condition was thought to be operable but who did not return because it is quite likely that the same ratio of 80 per cent operability would hold as it did in the group of 70 cases so that the figures would not be altered.

Of the 57 completed consecutive operations the type of operation performed is shown in Table III.

TABLE III

	Cases
Combined abdominoperineal 1 stage	54
Colostomy and posterior resection	1
Colostomy and segmental resection	1
Electrocoagulation (early lesion)	1
Total	57
Mortality in this series	4
Based on 56 major procedures	7.1%

MORTALITY

From Table III it will be seen that 80 of the 100 consecutive cases were considered operable clinically, but 10 patients did not return so that 70 entered the hospital for radical operation. Due to reasons stated previously operation was incomplete in 13 cases. 8 patients had colostomy only, and 5 did not. There were no deaths in this group. In the 57 remaining cases 56 major procedures were carried out. Fifty-four of these were combined one stage procedures, and there were 2 two-stage procedures. The additional case an early one in which electrocoagulation was done, is not counted as a major procedure and was not included in the mortality statistics.

In this group of 56 cases there were 24 females and 32 males and their ages were as follows:

TABLE IV — AGES

	Cases
25 to 30 years	1
30 to 40 years	8
40 to 50 years	10
50 to 60 years	10
60 to 65 years	11
65 to 70 years	9
70 to 80 years	7

It will be seen that more than one third of these patients were between the ages of 60 and 70 years.

In the 56 consecutive cases in which a major operation was performed, 4 deaths occurred a mortality of 7.1 per cent. Based on the 54 one stage procedures in which the deaths occurred it was 7.4 per cent.

The causes of death are shown in Table V.

TABLE V — CAUSES OF DEATH

	Cases
Peritonitis	2
Pulmonary embolus	1
Bronchopneumonia	1

One case of peritonitis and one of pulmonary embolus were proved at autopsy; the 2 others were clear cut clinical diagnoses (Table VI).

TABLE VI

No.	Sex	Age	Death after operation	Cause of death
1	M	31	12 days	Peritonitis and obstructed colon
2	F	6	70 days	Pulmonary embolus and thrombosis in a patient ready to go home (autopsy)
3	M	35	3 days	Definite peritonitis (clinical)
4	M	65	4 days	Peritonitis, at-once died in hospital. Cause of death not clear. (autopsy)

From the standpoint of operability and mortality, it is obvious then that the one stage procedure compares quite favorably with the multiple stage procedures. For purposes of analysis and comparing operability figures the simple table described previously is suggested.

TRANSVESICAL DIATHERMY IN THE TREATMENT OF CARCINOMA OF THE BLADDER

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Philadelphia, Pennsylvania

CARCINOMA of the bladder, despite the varied technical procedures devised for its management, remains a distinct problem in the field of urological surgery. Success in its treatment, commensurate with knowledge thus far attained in reference to carcinoma in general, lies in early diagnosis and prompt institution of therapy. Centralization of therapeutic data for analysis and statistical appraisal, as embodied in the Tumor Registry of the American Urological Society, will accomplish much in guiding the future therapy of this disease.

The surgical pathology of vesical neoplasia offers a distinct challenge to those who undertake its management, for the bladder must not be considered a single physiological unit but an integral part of the entire urogenital synchronization. Individualization in the selection of treatment is therefore necessary and should be guided by the characteristics of the neoplasm, its location, its size, its relationship to renal function or dysfunction, its extension into and beyond local barriers, and finally, the physical potentialities of the patient himself. Dart, recently, in reviewing 1,224 tumors of the bladder, emphasized that cellular differentiation must be supplemented by the physical characteristics of the growth if one wishes to grade carcinoma.

The multiplicity of the methods of surgical management permit a wide latitude of choice. One of these, transvesical diathermy or electrocoagulation, has received minimal consideration in the medical literature since its clinical elaboration by Corbus in 1921. Recently there have been a few articles reporting favorably on its use (4, 8). Stimulated by these observations, a survey of the case histories of patients treated by this method in the Urological Clinic of the Hospital of the University of Pennsylvania between the years 1923 and 1936 has been made.

CLASSIFICATION OF ELECTROSURGERY

The older method of destroying bladder carcinoma with the Percy cautery and glowing solder-

From the Department of Urology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania.

Presented before The Philadelphia Urological Society, May 24, 1937.

ing iron met with moderate success. However, because of the rapid evolution of electrophysics and the introduction of refined electrosurgical equipment, these cruder methods have been displaced.

In general, electrosurgery, embodying the principles of the high frequency currents, has a three-fold clinical usage: first, the rapid, bloodless, aseptic severance of the normal tissue; second, the excision or destruction of malignant tissue; and third, the coagulation of blood vessels.

The electrosurgical domain is composed of four general groups: (1) "Acusection" refers to the cutting of tissue with the high frequency current. This term is derived from "acusector," an instrument devised by Kelly and so named by him to differentiate the electrosurgical "knife" from the scalpel. (2) "Electrodesiccation" effects destruction by dehydration, the current being of the unipolar Oudin type. (3) "Electrocoagulation" implies a thermic reaction, death of tissue being produced by heat coagulation of the tissues. This current is of the bipolar d'Arsonval type. (4) The term "diathermy" is synonymous with electrocoagulation. The dissimilarity in nomenclature represents a time factor: the longer the application of current, the more extensive the thermal effect in the tissues. Diathermy, therefore, implies a deeper penetration of heat; consequently its destructive effect is greater.

DIATHERMY

The physical limits of diathermy and its effect upon tissue depend on the amount of current generated and its length of application. Radicalism in its application to vesical carcinoma is not warranted, for extensive necrosis and sloughing lead to fistulous communication with contiguous structures—the vagina, rectum, and peritoneum. The cure, if the patient survives, then becomes worse than the disease.

Corbus used 1 ampere of current per application of electrode in his experimental work and postulated as a time limit of sufficient application a blanching and bubbling up of tissue. In 1925, Cunningham, Graves and Bovie clinically introduced the use of thermocouples in the bladder

wall to control scientifically the thermal effects of diathermy. Heat was recorded from rectum and vagina as an additional means of protection.

Our own technique consists in the setting of the high frequency apparatus so that with each application there is a delivery of 1500 to 2000 milli amperes through a flat disc electrode which measures 1 centimeter in diameter. The amount of time to produce ischemia and bubbling of tissue with the liberation of gases is taken as a criterion of sufficient length of application. This factor will be found to be directly proportional to the size of the electrode employed: the larger the electrode, the longer the period of time to obtain ischemia. A finger in the rectum or vagina is of distinct value in elevating the bladder floor, while epicritic sensation is an additional safeguard against too liberal diathermy.

Current delivered through the active electrode is concentrated in a small area and travels in a perpendicular and radiating direction therefrom. Coagulation is said to occur to a depth approximately equal to the diameter of the electrode, while the immediate peripheral zone is also affected. As the current blends out in the deeper structures coagulation is not produced but the thermal effect is sufficient to interfere with the vitality of cells. Thus there is what can be called an immediate direct and an immediate indirect reaction. Blood and lymphatic vessels are like *wire sealed* which is an additional safeguard against local growth and metastasis.

Corbus summarizes his experimental work with diathermy on dogs as follows:

The immediate effect is a slow cooking through of the underlying tissues, the effect upon the deeper structures being the same as that upon the mucosa. This is followed by an aseptic death of the submucosa and muscular. Round cell infiltron is marked only for the first 3 days. Eventually the entire area is replaced by a dense proliferation of fibrous tissue, the line of demarcation between the treated area and the surrounding normal tissue being definitely preserved.

The ureteral wall may be burned back in the dog almost to the entrance of the intramural portion. The results in 3 dogs under observation for from 3 to 5 months have shown no derangement of function in the ureteral activity or the contractility of the bladder. No obstruction to the ureteral outflow occurred in five months.

It is constantly to be borne in mind that Caulk and Harris showed that this current traveling from the active to the inactive pole followed the channels richest in electrolytes by preference. This means that the urine, the lymph, and the blood channels get the greatest current load and in these channels the coagulating effect has the greatest penetration and depth.

SELECTION OF TREATMENT

Our premises of therapy do not differ materially from those in many other clinics. Nevertheless, we feel that in attempting to achieve a so called cure, selection of treatment should be individualized and should be sufficiently radical to carry a minimal risk of operative mortality and to promise a convalescence free from excess morbidity.

The most radical procedures, such as total cystectomy, transplantation of the ureters and subtotal resection, while theoretically appealing, become less so in clinical application, because, if success is to be attained, cases must be chosen early when the growth is still small and localized (a clinical exception rather than the rule). In making a decision in this period of the growth cycle, a less radical procedure is frequently as effective and one does not always feel justified in subjecting his patient to additional hazards. Bumpus (3), in the discussion of Rathbun's presentation 'Comments on Bladder Carcinoma,' has very wisely remarked: 'If the chances of cure were equal to the risk involved in these major procedures they might be more readily justified, but when the mortality rate incident to the treatment considerably exceeds that of the possibility of cure, it seems as though more conservative measures can be justified in many cases.'

Tumors occupying the vertex of the bladder are amenable to segmental resection, but by far the greater incidence of malignant involvement is found in the base of the bladder where less enterprising measures have to be adopted. If tumors are small and accessible they warrant transurethral cystoscopic destruction, but we feel that tumors of any magnitude with a cystoscopic index of malignancy and invasiveness should be subjected to transvesical excision and diathermy. In extensive vesical carcinoma, if renal function is still maintained as revealed by urography, if urosepsis has not appeared and in the absence of local or distant metastasis, diathermy is especially applicable. Involvement of a ureteral orifice with a resultant functionless kidney is not a contraindication to the use of diathermy.

If tumors small or large are associated with concomitant pathology in the prostate, such as adenomatous hypertrophy or changes in the vesical neck, necessitating operative intervention, cauterization and diathermy of the tumor can be carried out in addition without fear of increasing surgical shock.

CLINICAL RESULTS OF DIATHERMIC TREATMENT

Counseller and Braasch in 1935 reported their results in 17 cases of carcinoma considered non

resectable from the extensive involvement of the base of the bladder. In 5 patients, the ureteral orifices could not be found since they were hidden by the growth or occluded by it. Fourteen patients were treated only with diathermy and 3 had a combination of cautery excision and diathermy. Four cases were graded 4, 5 were graded 3, 4 were graded 2, and 4 were graded 1. Fifteen of these patients, or 88 per cent, lived over 5 years and were free of recurrence. Irradiation or radium was not used as adjuncts in treatment.

Bumpus and Silver analyzed a group of 43 cases treated similarly and deducted that they obtained "approximately a 19 per cent possibility of a 3 to 5 year cure by this method."

The subject of our report is a series of 51 cases treated by transvesical diathermy between November, 1923, and July, 1936. Due to the small number of patients and insufficient time interval of follow-up in a few, they shall be considered under 3 general headings. (1) the dead; (2) the living; (3) the indeterminate.

1. There were 29 deaths in 51 cases, a mortality of 56.8 per cent. Analysis of these confirmed the oft repeated statement that the cause of death in vesical carcinoma is, in most instances, attributable to renal infection and renal failure. There were 27 cases of papillary carcinoma, 1 case of adenocarcinoma, and another case with a large growth classified as a papilloma.

Five of the 29 deaths were classified as operative deaths, a percentage of 9.8 for the entire group of 51 cases. Two of these deaths followed the second transvesical operation for extensive recurrence. The third patient died as a result of poor cardio-renal reserve after combined suprapubic prostatectomy and transvesical diathermy. The fourth and fifth patients lived 9 and 22 days, respectively, after operation, the causative factors of death in each case being marked urogenital sepsis with secondary blood stream invasion.

A sixth patient was known to have died and, despite the fact that no record of survival period or recurrence could be found, was considered in this tabulation.

The 23 remaining cases were grouped into survival periods as follows:

- 5 survived 1 to 6 months
- 11 survived 7 to 12 months
- 3 survived 13 to 18 months
- 4 survived 24, 32, 34 and 44 months, respectively.

There is insufficient follow-up data in 3 of these 23 cases as to whether or not recurrence was present at the time of death, although the period of survival in each is recorded as 8, 32, and 44 months. In the 20 remaining cases, in which the

follow-up data are accurate, recurrence was found in 17 cases and no recurrence in 3.

Further analysis of these 3 cases of non-recurrence disclosed that 1 had had a large basal growth, diagnosed papilloma. This was diathermized transvesically 24 months before a cautery-punch operation of the vesical neck was performed, from which the patient succumbed.

The second patient survived 4 months after operation. No recurrence was found in the bladder, but the chest harbored extensive metastases.

The third patient free of recurrence died 12 months after operation from pneumonia. Just prior to the patient's hospitalization for this fatal illness, cystoscopic examination disclosed the absence of recurrence, and the retraction of the right ureteral orifice into the depths of a scar. This scarring with retraction of the ureteral orifice Corbus mentions in his experimental work. No estimation of right renal function was tabulated.

2. The living group consists of those patients who have been personally contacted and studied in the preparation of this report. They number 14, or 27.4 per cent of the entire group of 51 cases. In each a diagnosis of papillary carcinoma was made. Eleven have been free of recurrences since the original operation, from 4 to 86 months.

The observation periods of these 14 living patients are grouped chronologically as follows:

- 2 patients have been observed 4 to 12 months
- 3 patients have been observed 13 to 24 months
- 2 patients have been observed 25 to 36 months
- 4 patients have been observed 37 to 48 months
- 3 patients have been observed 54, 74 and 86 months

Three patients followed 26, 40, and 44 months, respectively, were found to have had recurrences. Two of these 3 recurrences were not present at our last examination, due to control by cystoscopic fulguration. The third recurrence is extensive and is being treated with roentgen therapy.

3. This group includes a total of 8 patients whom we have been unable to trace either through letters, questionnaires, or the referring physician. There was histological corroboration of papillary carcinoma in each case.

Two patients were lost at the fourth month interval. Cystoscopy revealed at that time that each had an unhealed area covered with slough.

The third patient, age 39 years, examined 15 months after operation, had no recurrence and little scarring despite a large papillary infiltrating carcinoma.

The fourth patient, 72 years of age, with an infiltrating carcinoma, who also had a concomitant suprapubic prostatectomy, had no recurrence 20 months after operation.

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used routinely and no definite conclusions can be drawn. In isolated instances remarkable results have been achieved, while in others, no improvement was noted. Only in its routine use can a fair appraisal be given.

We urge rather than condemn surgery combined with one of the forms of irradiation. Andrews and Uhle, in a series of unselected cases of vesical carcinoma, showed that the 5 year survival period in the group treated by combined surgery and irradiation was 22 per cent compared to 7 per cent for the group managed by surgery only.

In 10 of the 51 patients constituting this report, who were followed from 40 to 86 months, 6 were treated with combined diathermy and deep roentgen irradiation. Three of these 6 patients had recurrent growths. Of the 10 patients, 4 were managed only by transvesical diathermy. One of these 4 had a recurrence of the tumor.

COMPLICATIONS OF DIATHERMY

Clinically, Counseller and Braasch have observed that none of their 17 cases had pyelonephritis secondary to diathermy despite the fact that the ureteral ostium in some of their cases was included in the electrocoagulation. They state "Complete healing occurred in every instance, leaving a clean scar with the ureteral orifice occupying a depression in the scar."

We have likewise had occasion to observe the clean scar and lack of vesical deformity left by diathermy. In some instances in which diathermy was applied in a limited small area, the scar was almost lost to view. Nevertheless, acute pyelonephritis has been a troublesome complication in a few of our cases and to avoid this a ureteral catheter is now introduced at the conclusion of the operation if the ureteral orifice or its immediate neighborhood has been diathermized.

Bumpus and Silver state: "In the transvesical series a ureteral orifice was included 29 times in the cautery destruction, and in 10 it was considered a decided factor in an unsatisfactory convalescence if not a direct cause of the patient's death."

Chronic pyelonephritis must be taken into consideration, too, for in two exemplary cases this complication has occurred secondary to ureteral orifice contracture. One patient has a recurring pyonephrosis which spontaneously empties itself into the bladder. Nephrectomy is anticipated. The second patient had an extensive papillary carcinoma of the retrotrigonal region treated with excision and diathermy. Death followed 8 months after operation. At autopsy, the bladder and its environs were grossly free of tumor, but micro-

scopic examination revealed small nests of tumor cells in the depths of the scar tissue which was minimal considering the extensive application of diathermy. Both ureteral orifices were stenosed with resultant bilateral hydrophyonephrosis. The primary cause of death was a ruptured gangrenous gall bladder and peritonitis. We, therefore, suggest to incorporate in the follow-up treatment the dilatation of one or both ureters at periodic intervals after the immediate convalescence, in an attempt to maintain adequate renal drainage and reduce the incidence of morbidity.

Only one patient developed a fistulous communication after diathermy. A vesicovaginal fistula complicated an extensive grade 3 infiltrating basal growth 5 weeks after operation. This patient survived 9 months. The cause of death was attributable to recurrence of the growth, urosepsis, and uremia.

The immediate effect of diathermy is an aseptic necrosis. If infection supervenes, various gradations of severity from the simple to the more virulent with pelvic cellulitis, phlebitis, septicemia, and death can occur.

Later in the convalescence (1 to 4 months) sloughs denuded from the operative area may lead to dysuria and even retention of urine requiring catheterization. These pieces of tissue, in our experience, have always been spontaneously voided and have never been associated with troublesome bleeding.

Shivers has recently observed ureteral reflux as a late result of diathermy.

SUMMARY AND CONCLUSIONS

- 1 The therapy of vesical carcinoma should be selective. Transvesical diathermy is of value in the treatment of lesions involving only the basal regions of the bladder and those not amenable to bladder resection or to transurethral management. The indications and technique of diathermy have been discussed.

- 2 The safety of transvesical diathermy is shown by an operative mortality of 9.8 per cent.

- 3 The three most important complications of diathermy are the establishment of fistulous communication between bladder and rectum or vagina, acute pyelonephritis, and chronic pyelonephritis. Fistulas can be prevented by curbing the overzealous application of the high frequency current. There was only one fistula (vesicovaginal) in our series. The incidence of acute pyelonephritis can be reduced by the introduction of a ureteral catheter for drainage at the conclusion of the operation if diathermy has been applied directly over, or in close proximity to, the ureteral

The fifth patient, with a large ulcerating carcinoma was free of recurrence 22 months after operation. At this time, malignancy was discovered in his throat.

The sixth patient was free of recurrence for 32 months, when multiple papillomas appeared. These were periodically fulgurated over a period of 23 months. The patient was lost from the follow up service after a total observation of 55 months.

The seventh patient had had a mid trigonal lesion diathermized. A small papiloma was discovered 74 months later in the center of the scar. Following fulguration the patient never returned.

The eighth patient had a pedunculated carcinoma filling half the bladder cavity. Cystoscopy at an interval of 75 months disclosed no recurrence.

SUMMARY OF GROUPS 1, 2, AND 3

There were 20 deaths in 51 cases, a general mortality of 56.8 per cent. Five, 9.8 per cent were considered operative deaths. From the available statistics of 23 deaths, their survival period ranged from 1 to 44 months. Three patients lived 8, 32, and 44 months but no information could be obtained of the presence or absence of recurrence. 17 patients had recurrences at the time of death, 1 to 34 months after operation, while three patients were free of recurrence 4, 12, and 24 months, after operation.

Fourteen, or 27.4 per cent, of 51 patients were alive at the time of this study. Eleven were free of recurrence with follow up periods of 4 to 80 months, 3 had had recurrence and had been followed 26, 40, and 44 months.

Eight cases classified as indeterminate were considered separately because the final disposition of the cases was not known (5 were lost at short intervals of time). Three patients had had lengthy follow up periods of 55, 74, and 75 months, with recurrence detected in 2.

There were 24, or 47 per cent of the entire group of patients who gained vesical cure and comfort from the operative procedure. 'Cure' refers to those patients, 18 in number (35.3 per cent of 51 cases), who demonstrated no signs of local recurrence irrespective of the time limit of observation. Comfort implies the absence of distressing vesical symptoms and refers to the status of 6 of our patients who had small recurrences satisfactorily controlled by cystoscopic fulguration.

TECHNIQUE OF TRANSVESICAL DIATHERMY

The bladder is opened through the customary suprapubic extraperitoneal approach. Adequate

exposure of the region harboring the growth is imperative, for only in the adoption of this surgical principle can satisfactory electrosurgical work be accomplished.

Whenever possible the cautery loop electrode should be employed first to cut away the tumor including a 1 centimeter 'collar' of healthy tissue. The depth of severance extends to the muscular layers, care being taken not to penetrate the bladder wall. If there is any apprehension, extra peritoneal drainage should be used. In the basal regions, deep excision may lead to fistulous communication while diathermy *per se*, if applied too long, may establish false passages. The ureteral orifice, and a portion of the trigone and the vesical sphincter can, in our experience with comparative safety to the patient, be excised if infiltrated with neoplasm.

Pilcher and Cabot have drawn attention to total resection of the vesical neck combined with subtotal removal of the trigone in the female with resultant normal bladder function and normal control of urination.

Following cautery excision, the flat disc electrode is very lightly applied to the denuded area and an additional 1 centimeter of peripheral healthy tissue, until the blanching of cooking tissue and muscular contractions indicate an adequate diathermic exposure. Between 1200 and 1500 milliamperes are delivered per application. At each application the electrode is lifted the moment that bubbling appears around its periphery and it is to be accentuated that only the light contact with the tissue is to be applied and all actual sparking is to be avoided. Charring of tissue to a peculiar dirty green color commonly occurs in the area previously excised. In some instances, operators prefer the use of diathermy alone to control small or extensive growths.

At the conclusion of the operation, the bladder is carefully inspected for hemorrhage which, in our experience, has been negligible. If the ureteral orifice, or its immediate periphery, has been diathermized a ureteral catheter is introduced the end of which is brought out through the suprapubic wound and attached to a tube leading to a separate drainage bottle.

The bladder is closed about a large mushroom catheter which is not removed for a period of 2 to 4 weeks, depending upon the extensiveness of the cautery excision and diathermy. Too early removal leads to dysuria, tenesmus and bleeding.

DIATHERMY AND IRRADIATION

In this series of 51 patients, deep roentgen therapy, radium radon, or a combination was not

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SOME SCANDINAVIAN CLINICS

THE Society of Clinical Surgery which makes a trip to foreign surgical clinics every five years or so, went to Scandinavia during the summer of 1937. These countries were chosen partly on account of a belated recognition of the fine scientific work which has been carried on there for many years, partly on account of the desire to see the workings of the "Middle Way," partly on account of their freedom from the threat of war, and partly, it is necessary to confess, on account of their scenic attractions. The choice proved a happy one, combining profitable professional experience with the delight of beautiful scenery.

The scientific contacts between the Scandinavian countries and our own have been rather remote until recent years. These nations traditionally looked to Germany and the British Isles in medicine as they did in commerce. Recently awards of the Nobel prize in medicine across the Atlantic have provided evidence of the attention that medi-

cal progress in this continent has been gaining there. While on our part, the work of men like Krogh in physiology, Svedberg in chemistry, and the clinical investigation in centers like the Radiumhemmet and the Finsen Institute have impressed us with the caliber of the medical sciences in Scandinavia.

In surgery this community of interest has been shown by the appearance of several of the outstanding Scandinavian surgeons such as Einar Key, Gunnar Nystrom, and Knut Giertz, as the principal guest speakers before the American Surgical Association and other important surgical meetings. Scandinavian contributions to the progress of surgery have been outstanding in many fields, particularly in the operative treatment of tuberculosis, in embolectomy, in traumatic surgery of bone, and in the practical development of radiation therapy. The recent untimely death of Professor Christian Jacobæus recalled the many contributions of this great internist in the field of pulmonary disease, including his pioneer work in devising a method of dividing intrathoracic adhesions.

Outstanding centers of surgical interest are the clinics in the three capitals, Stockholm, Copenhagen, and Oslo, the University Clinic at Uppsala and that of the Sahlgrenska Sjukhus in Göteborg. Nearly all of the hospitals are of the pavilion type in extensive grounds made beautiful in the summer time by a profusion of luxuriantly blooming flowers. However, some of the most recent additions, such as the new Pathological building at the Sabbatsberg Sjukhus, are excellent examples of the modernistic style that one sees extensively in the attractive co-operative apartment buildings. The hospital wards were neat but usually plain while the operating rooms were uniformly well

orifice Stenosis of the ureteral orifice secondary to healing fibrosis is a later manifestation of the effects produced by surgical diathermy Renal morbidity (chronic pyelonephritis) can be lessened by periodic ureteral dilatation during the period of the patient's follow up

4 Diathermy produces an aseptic necrosis If infection supervenes the progression of pathological events ranges from the simple to the fulminating type with pelvic cellulitis, pelvic phlebitis, and death

5 Cicatricial reaction following diathermy does not produce marked vesical deformity In spite of extensive diathermy, scarring is often minimal and in 47 per cent of patients vesical comfort and silence can be acquired

6 There was a general mortality of 56.8 per cent Death was ascribed in this group to recurrence of the growth with secondary renal infection and uremia Other contributory factors were distant metastases, unhealed suprapubic sinuses and septicemia Cordotomy was performed in 1 case for relief of intractable pain

7 No evidence of recurrence irrespective of the time limit of follow up, was found in 35.3 per cent Recurrent growths developed in 43.1 per cent

8 Routine cystoscopy, after operation, is of great importance in detecting early, or late recurrences In 1 instance a papillary recurrence was found 74 months after the original operation Cystoscopic fulguration is sufficient to effect control

9 The importance of an efficient follow up service cannot be overemphasized Ten patients, 19.6 per cent, were followed from 40 to 86 months Four had recurrences and 6 were free of recurrence

10 We have been unable to substantiate the figures of Counsellor and Braasch (88 per cent living over 5 years and free of recurrence) but feel that the results of diathermy in the treatment

of carcinoma of the bladder are significant and should foster a wider clinical interest in this method of treatment

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Swedish people to constituted authority and in the relative stability and official recording of the place of residence of the people. And in the third place, governmental socialization assists, by making it possible to transport indigent patients from any distance to the clinic without cost to themselves.

The outstanding surgical feature in Oslo was the demonstration by Professor Holst of his method of extrapleural apicolysis combined with thoracoplasty for the obliteration of tuberculous cavities in the upper lobe. In Bergen we had visible evidence of a splendid medical victory: large institutions built for the care of hundreds of lepers today only have one or two remaining patients.

One of the most interesting features of the Scandinavian visit was the opportunity to see the impact of a plan for national socialization upon the practice of medicine. Probably no two members of the group came away with just the same impressions concerning this. But the following general conclusions seem valid. An excellent grade of surgery in general obtains today in the best Scandinavian clinics, and the medical profession occupies a position of high esteem in the community. However, there are some difficulties in medical practice already apparent that may be inherent in this type of organization or may only require certain adjustments. Most of the doctors must either seek and obtain hospital positions (on state or municipal salaries) or must support themselves by the care of a regulated number of state insurance cases at approximately \$2 25 per person a year, as the amount of private practice is almost negligible (except for a very few specialists). In either of these cases, this results in a very small cash income for the greater part of the doctor's professional life. Although with the aid of co-operative buying and the provision of quarters and food by many hospital positions, his income is usually ade-

quate for a fairly comfortable livelihood, it rarely allows for such important educational elements as visiting foreign clinics or other "brain dusting" opportunities. Another difficulty in working such a plan appears in the following situation. A separate group of physicians has had to be appointed for emergency night calls as it has become practically impossible to get a doctor after six p m for one of his state insurance cases. It was even difficult to obtain a narcotic prescription as an emergency in the evening for one of the doctors in our party. Thus the concerted action of the profession in attempting to overcome one unfortunate effect of the system has resulted in a lowering of the quality of the service rendered in another direction to the public.

There is one suggestion which should be made to those planning a trip to the Scandinavian countries including the visiting of its hospitals and clinics. Due to the many months of short days, everyone there takes the maximum possible advantage of the luxuriant summer season. Consequently, for the months of July and August the work in medical institutions is on a very restricted vacation schedule. Thus if one wishes to combine a scenic summer vacation with an opportunity of seeing Scandinavian surgery, the trip should be planned to visit the Scandinavian clinics either in the latter part of June or the early part of September.

W J MERLE SCOTT.

ETHER ANESTHESIA

ETHER anesthesia induced by the open drop method is still the best method of general anesthesia in the hands of the average person. Not infrequently it should be resorted to even by expert anesthetists when the results which they are attempting to obtain by some other method of anesthesia are unsatisfactory both from the standpoint of

equipped with excellent rustless steel instruments. Interesting clinical programs given by the speakers in English, were arranged most courteously for the Society by all of the chief surgeons of the clinics visited. In Sweden's western seaport city, Goteborg, Dr. Johansson gave an impressive demonstration of his method of treating medial fractures of the femoral neck by extra articular osteosynthesis. We were interested to see that the Finsen-institute in Copenhagen had become also a radium center where the treatment of carcinoma was receiving almost as much attention as all forms of surgical tuberculosis. The Institute represents the perpetuation, under modern conditions and with government support, of the work of a universally beloved pioneer. Finsen's achievement in establishing this Institute is all the more remarkable as he was seriously ill at the time, dying, in 1904, of pericarditis. Lupus, extremely prevalent when he did the initial work with ultra violet treatment, has now become relatively uncommon even in Denmark and ultra violet radiation no longer plays the outstanding rôle that it once did in the Institute's therapeutic program. Patients with surgical tuberculosis are still given carbon arc light baths for an hour daily for its general effect. But with the diminution in surgical tuberculosis, the Institute has enlarged its program and the treatment of all types of neoplasm is carried out.

Many interesting clinical investigations were described to us in the various clinics. Dr. Chiewitz reported the removal of a parathyroid tumor which was found in the mother because its presence had resulted in tetany in her nursing baby. Dr. Crafoord described the use of a purified heparin as an anti coagulant, given intravenously to the donor before with drawing blood for transfusion. In Dr. Berglund's medical clinic there was given an excellent demonstration of the newer methods of

studying the stomach and pancreas including gastroscopy and the response to secretion. Perhaps the most interesting innovation in diagnostic study was the method worked out by the late Professor Jacobæus with Drs. Björkman and Frenckner. This procedure called bronchospirrometry determines the respiratory function of each lung separately. It is already yielding data of great value both scientifically and also clinically in directing therapeutic measures. Thus it has been found that the functional capacity and roentgenographic appearance of the diseased lung may be significantly at variance.

The Radiumhemmet in Stockholm is probably the most famous center in the world for the irradiation of malignant disease. Like the Finsen-institute, it is a living memorial to the vision, energy, and devotion of its founders, in this case two men, one dead and one still living, Dr. Berg and Dr. Forssell. There are many fine features of the splendid work being done there, the organization of the clinics, the skill in devising apparatus and in measuring physical effects, the impartiality in judging between all alternative methods of treatment, the quantity of radium available (about 10 grams in all, of which 5 grams are in ore bomb) and the persistence with which even apparently insurmountable obstacles are attacked. But the most impressive feature of the clinic was the remarkable following of cases. Less than 10 per cent of all their thousands of cases are lost track of. And in some series including over 500 patients, the result in every case treated is known to date. This remarkable record is to be credited to several factors. In the first place the energy and devotion of the doctors following individual groups and the efficiency of the follow up system used are important. In the second place, there are significant sociological factors in the respect and obedience of the

Swedish people to constituted authority and in the relative stability and official recording of the place of residence of the people. And in the third place, governmental socialization assists, by making it possible to transport indigent patients from any distance to the clinic without cost to themselves.

The outstanding surgical feature in Oslo was the demonstration by Professor Holst of his method of extrapleural apicolysis combined with thoracoplasty for the obliteration of tuberculous cavities in the upper lobe. In Bergen we had visible evidence of a splendid medical victory: large institutions built for the care of hundreds of lepers today only have one or two remaining patients.

One of the most interesting features of the Scandinavian visit was the opportunity to see the impact of a plan for national socialization upon the practice of medicine. Probably no two members of the group came away with just the same impressions concerning this. But the following general conclusions seem valid. An excellent grade of surgery in general obtains today in the best Scandinavian clinics, and the medical profession occupies a position of high esteem in the community. However, there are some difficulties in medical practice already apparent that may be inherent in this type of organization or may only require certain adjustments. Most of the doctors must either seek and obtain hospital positions (on state or municipal salaries) or must support themselves by the care of a regulated number of state insurance cases at approximately \$2 25 per person a year, as the amount of private practice is almost negligible (except for a very few specialists). In either of these cases, this results in a very small cash income for the greater part of the doctor's professional life. Although with the aid of co-operative buying and the provision of quarters and food by many hospital positions, his income is usually ade-

quate for a fairly comfortable livelihood, it rarely allows for such important educational elements as visiting foreign clinics or other "brain dusting" opportunities. Another difficulty in working such a plan appears in the following situation: A separate group of physicians has had to be appointed for emergency night calls as it has become practically impossible to get a doctor after six p. m. for one of his state insurance cases. It was even difficult to obtain a narcotic prescription as an emergency in the evening for one of the doctors in our party. Thus the concerted action of the profession in attempting to overcome one unfortunate effect of the system has resulted in a lowering of the quality of the service rendered in another direction to the public.

There is one suggestion which should be made to those planning a trip to the Scandinavian countries including the visiting of its hospitals and clinics. Due to the many months of short days, everyone there takes the maximum possible advantage of the luxuriant summer season. Consequently, for the months of July and August the work in medical institutions is on a very restricted vacation schedule. Thus if one wishes to combine a scenic summer vacation with an opportunity of seeing Scandinavian surgery, the trip should be planned to visit the Scandinavian clinics either in the latter part of June or the early part of September.

W. J. MERLE SCOTT.

ETHER ANESTHESIA

ETHER anesthesia induced by the open drop method is still the best method of general anesthesia in the hands of the average person. Not infrequently it should be resorted to even by expert anesthetists when the results which they are attempting to obtain by some other method of anesthesia are unsatisfactory both from the standpoint of

relaxation and from that of quiet respiration. This is especially true when less potent agents than ether are being used and when a more complicated method of administration is being persisted in after the entire surgical team realizes that satisfactory anesthesia has not been accomplished.

It will also be found in a certain number of cases in which anesthesia using a gas machine does not produce relaxation and quiet breathing that this can be accomplished by administering ether by the open drop method. In many instances even fifteen to thirty minutes of anesthesia with ether by the open drop method will permit further maintenance of anesthesia with a gas.

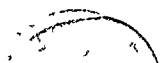
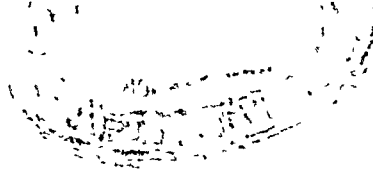
There has been a tendency in the last few years to advocate the use, almost routinely in many cases, of new agents and methods which are incapable of producing entirely satisfactory anesthesia in all cases. As a side result of this, some anesthetists who have received their training in the last few years have not had an opportunity to become skilled in the administration of ether by the open drop method. This is without doubt a mistake that will sooner or later have to be rectified, and it seems timely now to advocate that all anesthetists, of whatever degree of skill, keep themselves well trained in the use of ether by

the open drop method. They should in turn insist that their students and all others who come under their influence also become proficient in the administration of ether.

Anesthetists should not feel chagrined in going from other methods to drop ether anesthesia if conditions are unsatisfactory and if the patient's physical condition permits. On the other hand, they should feel that they have exhibited good judgment in adapting the anesthetic to the patient rather than the patient to the anesthetic, and in thereby providing the surgeon with conditions under which he may have the best opportunity to produce maximal surgical results.

This must not be interpreted to mean, however, that administering ether by the open drop method does not have its disadvantages and that there are not numberless cases when other methods are to be preferred and when they are entirely satisfactory. For that small percentage of cases in which difficulties do arise, however, they can be eliminated by the use of ether by the open drop method. In such cases, therefore, and in the hands of the average person, anesthesia by the open drop method is a satisfactory method. Let the anesthetist turn to this method and not avoid it as one that he should be ashamed of.

JOHN S. LLOYD





AUGUST F. JONAS
1858-1934

MASTER SURGEONS OF AMERICA

AUGUST FREDERICK JONAS

ON June 12, 1858, August Frederick Jonas was born of German parentage in Columbia county, Wisconsin. His parents came to Wisconsin from Germany in the thirties of the last century, while they were still in their teens. In his infancy, the parents moved to Madison and there August Frederick was reared and educated.

As a boy in his middle teens he worked in a drug store in St. Ansgar, Iowa, and there among the mysteries of a pharmacy of pioneer days was born the desire and determination to study medicine. Guided by the idea that eclecticism meant something in advance of other systems of medical education and practice, he entered Bennett Medical College, Chicago, attended two courses of lectures and was graduated therefrom in the spring of 1877, at the age of 19 years. His first practice was at Sauk City, Wisconsin. Sauk City was settled by Germans who left Germany following the student revolution of 1848 and 1849 and their cultural influence was an inspiration to Dr. Jonas and he always felt that his five years at Sauk City profoundly influenced his subsequent life.

Medical education in the seventies was for the most part wholly unregulated by law and the prevailing system consisted of three years of study under a preceptor, including attendance at two courses of lectures at a medical college, before coming up for graduation. Becoming dissatisfied with his medical training, feeling that he had failed to get the best and most up-to-date in the medicine of that day, he went to Berlin, Vienna, and Paris for postgraduate study and to Munich in 1882, where he spent 2 years in Ludwig-Maximilian University and was graduated therefrom, *Magna cum Laude* in 1884.

Returning to Wisconsin in the fall of 1884 he located at Madison and remained there 2½ years. He desired a larger field and believed the size and importance of Madison would not satisfy his ambition to develop a worthwhile surgical practice, so he decided to take Horace Greeley's advice, "Go west."

In the spring of 1887 he located in Omaha, then as now, a growing city of much promise in the rapidly developing Middle West. Subsequent events proved his judgment sound, for here he was to carve a career the memory of which shall long endure. Here he married Dr. Metha Helfritz of St. Ansgar, Iowa, to whom, as a youth, he had revealed his ambition to study medicine and from her he received inspiration and encouragement to pursue that course. After marriage she practiced with him during the 6 years preceding her death.

Dr Jonas was one of the first to bring the message of antiseptic and aseptic surgery to Omaha. He early became interested in the then struggling Omaha Medical College, the immediate predecessor of the present Nebraska University College of Medicine and in 1892 he was made professor of clinical surgery. His active connection with the medical school as a teacher of surgery under various titles continued for 34 years. He was dean from 1898 to 1902. On retiring from the active work of the school in 1928 he was made professor emeritus and the same year the Nebraska University conferred upon him the honorary degree of LL.D.

Dr Jonas' work as a pioneer surgeon and teacher exerted a profound influence on Nebraskan and mid western surgery. As a surgeon he was conservative. As an operator speed and certainty were his gifts.

Additional hospital facilities were greatly needed in Omaha during the early residence of Dr Jonas. The matter was brought to a crisis (in 1891) when Dr Jonas made a proposition to the Methodist Church, then contemplating a new hospital, to give one half of his fortune at that time, if the Church would match it. The hospital was built. His contribution was said to have been thirty thousand dollars and his later contribution to the Methodist Hospital during his lifetime largely exceeded that amount. On opening of the hospital Dr Jonas was made chief surgeon for life.

In 1898 Dr Jonas was appointed chief surgeon of the Union Pacific railroad and held the position for 27 years until failing health caused him to resign. He almost wholly reorganized the medical department of the Union Pacific and its system of case records. "His work in this position has been outstanding as an administrator and as a surgeon with the result that the medical department under his jurisdiction is one of the best in the country." So wrote President Carl R. Gray.

Dr Jonas always took an active interest in medical organization and rarely missed a meeting. He appeared frequently on the programs and rarely missed an opportunity to take part in the discussion of surgical subjects and his contributions were always worthwhile. The Missouri Valley Medical Society, organized in 1888, was for many years the foremost medical society in all that territory tributary to the Missouri valley. Dr Jonas was a charter member and its president in 1894. He served the Western Surgical Association as president and at sometime was vice president of the American Surgical Association. In the early nineteen hundreds he was vice president of the American Medical Association and sometime chairman of the surgical section of the same body. He was a member of the Pan American Medical Association and attended the meeting held in Mexico City.

In 1905-1906 Dr Jonas was president of the Nebraska State Medical Association. He was one of the organizers of the present Omaha Douglas County Med

ical society and one of its early presidents. He was one of the organizers of the American College of Surgeons and always stood high in the councils of that organization. He was a member of the Société Internationale de Chirurgie.

During the World War, the Governor of Nebraska appointed Dr. Jonas special medical adviser to the governor with the rank of Captain. He was instrumental in the organization of Base Hospital No. 49 and in the organization of an Ambulance Corps from Nebraska.

Dr. Jonas was a tireless worker in his chosen field and for many years carried what amounted to a double load, a large private surgical practice and the chief surgeons'hip of a great railroad system, as well as instructor in surgery at the University Hospital.

He was generally considered one of the ablest surgeons of the Middle West and was well known as a surgeon all over this country and in Europe. He was a frequent contributor to medical literature. Collections of his reprints are to be found in several of the larger libraries. He wrote a chapter for Binnie's *Surgery*.

Of the opinion that a doctor should have interest aside from his profession as a relaxation, Dr. Jonas early became interested in mineralogy and geology and made a collection of minerals which ranks among the finest in the state.

In 1907 after a visit to Egypt, he became deeply interested in archeology and began to make a collection of Egyptian antiquities which contains many articles of historic interest and value. This collection has been presented by the family to the Joslyn Memorial in memory of Dr. Jonas. It will occupy a small room there.

Dr. Jonas spoke and read German and French with ease. He was a man of simple tastes and had high ideals of life. "Small talk" was not for him. He was a man of affairs and supported every movement looking to the growth and improvement of Omaha.

In 1907 Dr. Jonas and Miss Jessica Stebbins were married in Denver and the latter survives. To this union were born a daughter, recently married to Dr. Harold Gifford, Jr., son of the late prominent ophthalmologist, and two sons: one Dr. August Frederick Jonas, Jr., at present on the staff of the Johns Hopkins Hospital.

Dr. Jonas suffered a cerebral hemorrhage in 1927 resulting in an aphasia, from the effects of which he never fully recovered. He uncomplainingly accepted a life of impaired usefulness and invalidism. His greatness was most definitely expressed by the splendid way he met this challenge. He died November 1934, from a cerebral hemorrhage suffered two days before. F. A. LONG.

EARLY AMERICAN MEDICAL SCHOOLS

HISTORICAL SKETCH OF THE JEFFERSON MEDICAL COLLEGE

DAVID M. DAVIS, M.D., Philadelphia, Pennsylvania

In 1827 the entrance requirements of the first American medical school were established as a degree from a collegiate institution or evidence of enough knowledge of Latin, mathematics and natural and experimental philosophy as might be judged requisite to a medical education, and a general knowledge of pharmacy. In addition there must have been a sufficient apprenticeship to some reputable practitioner. This indicates that at the time medical education began in America medicine was seriously regarded as a learned profession. Owing to a lack of other resources it was necessary to finance these schools by means of the fees paid by the students and as enrollments grew the teaching of medicine became not only a source of honor and renown but a very lucrative occupation as well. Talented and ambitious young men were eager to take part in it and when existing schools afforded insufficient opportunities new schools were projected.

The Jefferson Medical College arose from such a project in which a remarkable young man of 29 years named George McClellan was the leading spirit. Opposed by the University already old and proud the project could not be consummated until the trustees of Jefferson College in Canonsburg, Pennsylvania had been persuaded to lend it their protection and the authority of their charter. The school opened in 1825 and was an immediate success. To McClellan belongs the credit for inventing clinical teaching and from the beginning he maintained a small dispensary—at first in a room which also served as the Dean's office—where students could observe clinical material. This room was in a reconstructed theater but in 1828 a new building for the faculty was erected by one of the trustees at Tenth and Sansom Streets where the school has remained ever since. In 1838 a separate charter was obtained and the association with Jefferson College ended.

McClellan the son of one famous soldier and the father of another was a brilliant surgical genius and

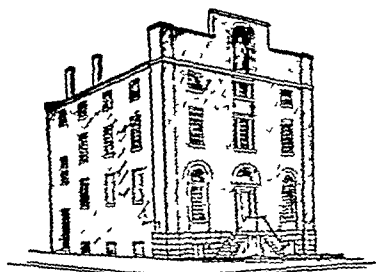
splendid teacher and a man of great energy. When representations had to be made to the Legislature he went to Harrisburg himself driving his own chaise and wearing out several horses on the journey. His able colleagues on the original faculty were John



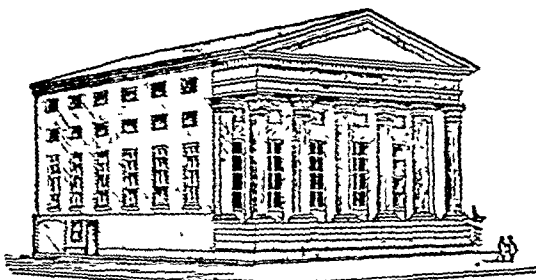
Dr. George McClellan, Founder of the Jefferson Medical College (from a daguerrotype)

Eberle, B. Rush, Rhees, Jacob Green, Nathan R. Smith and Francis S. Beattie. His positive, emphatic and enthusiastic qualities were undoubtedly accompanied by a good deal of impatience and arrogance as in spite of theuster he lent to the school there was constant dissension in the faculty, with frequent changes. In 1831 the trustees took matters in their hands and reorganized the faculty. McClellan refused to join in the reorganization and left to found another school which drew to it a good many Jefferson students at first but finally vanished from the scene. The 1831 faculty consisted of Muetter, Pancoast, Dunglison, Huston, J. K. Mitchell, Meigs and Bache. That McClellan was a stormy petrel is further evidenced by the fact that with his departure dissension was replaced by co-operation the school prospered might

ily and no further changes occurred until 1836, when death intervened. As the famous and successful professors retired or died they were replaced by others equally competent so that the school enjoyed an uninterrupted growth in prestige and authority for more than half a century and had a reputation second to none in the world. McClellan's principles of clinical teaching and constant actual contact between student and patient were followed from the beginning and had much to do with this success. The 1828 building contained a small dispensary in which operations were all performed and in 1844 two rooms over a shop adjoining the school were rented for the reception and care of patients after they had been operated on in the clinic. These primitive hospital facilities were enlarged until they included two entire floors and their value proved to be such that in 1877 they were replaced



The first building occupied by the Jefferson Medical College in Philadelphia, 1828



The Jefferson Medical College, as it appeared in 1846

by a commodious hospital building, which was the property of the medical school and created entirely as an adjunct to the teaching of medicine. Group teaching in the dispensary was utilized at first, but as the first class numbered 109 it had to be supplemented by the clinic, in which the patient was brought to the amphitheater and exhibited to large numbers of students. At an early date, clinics were also given at the Pennsylvania and the Philadelphia Hospitals.

Jefferson's renown through this long period can be expressed in the renown of the members of its faculty. In medicine there were Robley Dunglison, J. K. Mitchell, Roberts Bartholow, and Jacob M. DaCosta. In surgery, Thomas Muetter, Joseph Pancoast, Samuel D. Gross, Samuel W. Gross, John H. Brinton, and William W. Keen. In obstetrics, Charles D. Meigs and Theophilus Parvin. Muetter collected his famous museum, now the property of the College of Physicians of Philadelphia. The incomparable Gross organized the American Surgical Association and the Philadelphia Academy of Surgery. Meigs was a prolific author, highly respected and liked in Philadelphia, but at present better known to the world at large for his luckless polemic with Oliver Wendell Holmes concerning the contagiousness of puerperal fever.

The success of the school and its constantly growing student body eliminated financial difficulties for a long time and helped to attract the eminent men who joined the faculty. On the other hand, there was a huge and growing demand for medical education, new medical schools were arising everywhere, and medical education was gradually descending toward the chaotic period of 1870-1890, when cupidity reigned and proprietary abuses were at their peak. Jefferson could not escape the effects of this trend. At the beginning, in 1825, 1 year of apprenticeship and 2 years of lectures had been required. This shows that there was already much recession from the scholarly requirements of 1767, but in 1857 there was a further relaxation to 2 years of apprenticeship and 1 year of lectures, and nothing was said in the catalog about the character of the apprenticeship. The period of lectures in each year covered only 6 months. The faculty conscientiously strove against this tendency, but economic considerations forbade them to increase the requirement for grad-

uation. Instead they established a supplementary course of lectures covering 4 additional months each year and given without extra fee. All students were urged to attend it, but it was not compulsory. In addition, a student might attend a third year of lectures without charge. In other words, a good medical education was provided for those with the will to take it, but the others could still obtain a diploma after 6 months' attendance at lectures. It must be remembered that similar conditions prevailed in all other medical schools. Jefferson led in efforts to correct this lamentable state of affairs, as in 1872, long before any general campaign for improvement had begun, students were urged in the catalog to take their entire 3 years in Jefferson and to make their studies progressive. In 1879 the regulations of the newly formed Confederation of American Medical Colleges were adopted, and 2 years in medical school again required. In 1890, simple entrance requirements were initiated, and 3 years in medical school made compulsory. Since then the elevation of standards has continued steadily, along with those of other schools, and for many years they have been second to none.

The progress of medicine was closely followed. Before 1835 a museum of normal and morbid anatomy had been begun and in 1878 a separate pathological museum was added. In 1879, a new laboratory building was opened, the finest in the country at that time. In 1886, practical instruction in obstetrics, laryngoscopy, and ophthalmoscopy was instituted. In 1895, Jefferson pioneered with a required 4 year course. In 1896, X-ray equipment was installed and with the aid of the alumni the laboratory building was enlarged and re-equipped. This rising tide of necessities made huge demands on the financial resources of the institution, and it became more and more difficult to obtain contributions from the state or from individuals in view of the custom of dividing the surplus each year among the professors. The practice, in vogue everywhere at the time, began to be vigorously attacked from within the faculty, and in 1895 it was formally abandoned, to the satisfaction of everyone concerned.

In the last years of the Nineteenth Century and the first of the Twentieth, the stature of the school is indicated by the illustrious names connected with

it, such as Hobart Amory Hare and Thomas McCrean in medicine, J. Chalmers Da Costa and Gibbon in surgery, Solis-Cohen in laryngology, deSchweinitz in ophthalmology, Stelwagon in dermatology, Dercum in neurology, and Jackson in bronchoscopy. The Medical School building was greatly enlarged in 1909, and in the same year a new hospital of 300 beds was opened. In recent years three fine modern structures have been added—a new medical school, a fourteen story addition to the hospital, and the

Curtis out patient clinic. There are also separate buildings for the departments of anatomy and of diseases of the chest.

The Jefferson of today clings to tradition in that its methods of instruction have undergone less radical changes than those of many other institutions. It is proud of its successful career in the absence of any university connection. It is strong in the belief that it will continue to have, as in the past, such success as is deserved by the men who compose its staff.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IT IS certain that nearly every one who is interested in pulmonary tuberculosis or thoracic surgery already owns Alexander's *Collapse Therapy of Pulmonary Tuberculosis*¹ and is already aware of its excellence. Most have known that it was being prepared and have awaited its publication with curiosity and impatience—curiosity not as to its value (that was taken for granted) but as to its exposition of the present practice of the author and his evaluation of the practice of others.

A review, therefore, cannot be of value in describing and recommending it but does afford an opportunity of paying a tribute to its author and of analyzing his important position in the development of collapse therapy in pulmonary tuberculosis.

As one examines the history of the dissemination of medical ideas he is impressed with the reality of the barrier between nations and the necessity that in each country each new thing has its protagonist and popularizer. All of the measures of collapse of the lungs were developed in Europe and, with the single exception of artificial pneumothorax, had been in use there for many years before they were adopted in this country. Even pneumothorax, which was used here by Murphy and Lemke in 1898 and 1899, was soon abandoned and had to be reimported from Germany as late as 1912.

The surgical measures were only beginning to be used in America when, in 1925, Alexander's first book, *The Surgery of Pulmonary Tuberculosis* made its appearance. This afforded a necessary stimulus and immediately established its author as the leader of the advocates of this form of treatment—a position which he has since maintained. Besides contributing to the evolution of the procedures, he has made his department at the University of Michigan a proving ground for the new ideas of others. While many American surgeons were refusing to try this operation or the other, because they felt that it would not work, Alexander has tried them all and has helped to establish many as valuable. In doing this he has been meticulous in giving credit to the originators.

At the same time he has given a thorough training to a succession of young men from this country and abroad. In England and in many cities in America thoracic surgery has been stimulated and its direction influenced by men trained at Ann Arbor.

Until recently Dr. Alexander has been a full time surgeon at the medical school of the University of Michigan. One wonders to what extent the freedom from the uncertainties and the time-consuming

vexations of private practice have contributed to his work. As one looks over the list of American surgeons who are making important contributions to the science he is impressed with the fact that most of them occupy such positions. Alexander, Graham, Wangenstein, Ochsner, Whipple, Phemister, Cole, Churchill, Heuer, and Holman, are a few of an imposing list.

To return to the book under discussion, one cannot avoid making a few statements concerning the question of indications. On this subject there is, and probably always will be, a divergence of opinion, and it would be surprising if every one or, in fact, any one agreed entirely with Dr. Alexander. It would be out of place for the reviewer to express here his disagreements further than to say that the advisability of using phrenic nerve block in preference to pneumothorax, even in cases in which it is likely to prove effective, is very questionable; that the author's scant enthusiasm for the Semp apicolysis is not shared by most other surgeons and that his advice to proceed early to drainage of secondarily infected tuberculous empyemas is probably pernicious. On many of these questions the wise clinician will continue to withhold judgment and so avoid the deadening of curiosity which follows a formed opinion.

JEROME R. HEAD

THIS book, *J. B. Murphy, Stormy Petrel of Surgery*,² by Loyal Davis, is one of the most interesting contributions to surgical history that it has been my privilege to read. It tells the story of the life and work of a man who did as much to advance modern surgery as any one whom I have known, and the story is a stimulus to all who believe in the opportunity which America offers to the young man. To the older men of the disappearing generation who knew Murphy, it is a source of satisfaction that Murphy's example and achievement have been so well placed in print.

In the eighties of the Nineteenth Century, the work of Pasteur and Lister began to permeate American medicine. In the early stages there was so little understanding of the germ theory of disease that its application resulted rather in a ritual than in the use of aseptic and antiseptic methods. The carbolic acid spray appeared and disappeared, and other usages and procedures, futile or harmful, arose and vanished.

In the nineties came rapid advance in the sound application of the new knowledge to the science and art of medicine. In the spread of the new doctrine, Christian Fenger, of Chicago, a Dane, educated in

¹ THE COLLAPSE THERAPY OF PULMONARY TUBERCULOSIS. By John Alexander, B.S., M.A., M.D., F.A.C.S. Springfield, Ill., and Baltimore, Md. Charles C. Thomas, 1937.

² J. B. MURPHY, STORMY PETREL OF SURGERY. By Loyal Davis, M.D. New York: G. P. Putnam's Sons, 1938.

the Scandinavian seats of learning, demonstrated the principles of surgical pathology, and John B. Murphy became a leader in applying the new knowledge to general surgery.

During the Haymarket Riot in Chicago in 1886, newspaper comment first brought Murphy into the picture because of the daring surgery he undertook in rendering aid to the injured, and his success especially in the traumatic surgery of the abdomen was dramatic.

Murphy's scientific interest in many fields was phenomenal. In each field of work he made thorough preparation by preliminary experimentation and by careful study of surgical anatomy and pathology. His brilliant work helped lay a foundation for the great surgical advance of the succeeding years. The Murphy button, a mechanical device which started gastro intestinal surgery on its way, his work on surgery of the blood vessels and of the nervous system on the thorax, on the bones and joints, and on the endocrine system followed one after another in papers, discussions and clinical lectures.

Murphy was the greatest teacher of clinical surgery I have ever known. A kindly friendly man whom it was the good fortune of my brother Dr. Charles and myself to call friend as well as teacher, we look back to him with gratitude and loving remembrance. We would strongly urge every young man going into medicine and surgery to read Loyal Davis's life of Murphy for in it he will find courage and inspiration even when conditions appear most adverse.

W. J. Mayo

TO fill a need for a combined text and atlas of hematology Kracke and Garver have written a comprehensive volume. The first section of the book is devoted to a discussion of the principles of terminology and includes a dictionary of hematological terms. Many new terms based on Latin or Greek roots are recommended for example neutrocyte is preferred to neutrophil. Other new terms include acidoctye (eosinophil), basocyt (basophil), fragilocyte, meniscocyte, polychromatocyte, etc. Individual blood cells are then described and illustrated by colored drawings. For the most part the drawings are quite realistic and should assist greatly in identifying individual cells on blood films. The blast cells do not appear quite so realistic as they do not contain the fine chromatin structure that is usually seen in the nucleus. The colored plate of supravital stained leucocytes is good. The illustrations of blood films that accompany the clinical discussion of the various blood diseases is one of the

best features of the book. These blood films have been well chosen and represent clearly the hematological characteristics of the individual disease. They should prove of great value in a text the physician to interpret what he sees in the microscope.

The clinical and laboratory phases of the various blood diseases are discussed in detail. Very recent advances are included, and the authors frequently express their own opinions and experiences. Dr. James J. Clark has written a chapter on recent genologic treatment of the leucemic states. Dr. Francis P. Parker on blood groups and blood transfusions, Dr. Elizabeth Gambrell on malaria and Dr. R. P. Custer on bone marrow. Hematological technique is described in detail in the concluding chapter.

There are a few things that are open to criticism. Although the expression of hemoglobin in grams per 100 cubic centimeters is considered an advantage the authors use percentage hemoglobin and the grams per 100 cubic centimeters interchangeably throughout the book. It is also noted that little attention is paid to the saturation index or hemoglobin concentration of erythrocytes. In the text the terms hyperchromic, monochromic and hypochromic refer to the hemoglobin content of cells and not to the concentration. However in plate XII, red cells labeled as hyperchromic apparently have an increased hemoglobin concentration. It is not generally agreed that such cells actually occur. The etiological classification of anemias used is very similar to that of Minot and Castle. The discussion of the anemias in no way follows the classification. A large variety of anemias that are associated with a low color index are included under the term hypochromic anemia. This is confusing as it has become common to associate hypochromic anemia with iron deficiency. Following hypochromic anemia in order idiopathic hypochromic anemia, hemolytic jaundice, hypochromic anemia of lead poisoning, pernicious anemia, macrocytic anemia, aplastic anemia and sickle cell anemia are described. The reason for this arrangement is not clear. A feature of questionable value is the inclusion of a classification of anemias of childhood. These could well be discussed under the general headings of anemia. As the book is meant for reference purposes, it is lamentable that more space was not given to the anemias of bone marrow damage and dysfunction, e.g. Hant's disease and leuco erythroblastic anemia associated with metastatic carcinoma, xanthomatoses, etc.

Outside of the above criticism the book contains much to recommend it. In its scope the work is unique in this country. The book will certainly fill a useful place at the bedside in the clinical laboratory and in the student laboratory.

HOWARD L. ALST

1 DISEASES OF THE BLOOD AND ATLAS OF HEMATOLOGY WITH CLINICAL AND HEMATOLOGIC DESCRIPTIONS OF THE BLOOD DISORDERS INCLUDING A SECTION ON TECHNIQUE AND TERMINOLOGY. By Roy R. Kracke, M.D. and Florence Elliot Garver, M.S. Philadelphia: Lippincott and Montreal: J. B. Lippincott Co. 1937.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

FREDERIC A BESLEY, Waukegan, Illinois, *President*

HOWARD C NAFFZIGER, San Francisco, *President-Elect*

HENRY W CAVE, *Chairman*, HOWARD A. PATTERSON, *Secretary, Committee on Arrangements*

THE 1938 CLINICAL CONGRESS IN NEW YORK AND BROOKLYN

THE surgeons of Greater New York are planning to provide a program of surgical clinics and demonstrations that will present a complete showing of their clinical activities in all departments of surgery in that great medical center during the twenty-eighth annual Clinical Congress of the American College of Surgeons, October 17-21. The Committee is assured of the hearty co-operation of the clinicians at the five medical schools and more than fifty hospitals that will participate in the clinical program. Members of the Executive Committee in charge of arrangements are:

HENRY W CAVE, *Chairman*
HOWARD A PATTERSON, *Secretary*

FRANK E ADAIR
FRANK E BERRY
ROBERT E BUCKLEY
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WILLIAM DARRACH
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EUGENE H POOL
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BYRON STOOKEY
GEORGE GRAY WARD
BENJAMIN P WATSON
CARNE WEEKS
JOHN M WHEELER
ALLEN O WHIPPLE
PHILLIP D WILSON
ARTHUR M WRIGHT

A preliminary schedule of operative clinics and demonstrations is being prepared by the Committee for publication in an early issue of *SURGERY, GYNECOLOGY AND OBSTETRICS*. Clinics will be arranged for the afternoon of Monday, October 17, and for the mornings and afternoons of each of the four following days, in which all departments of surgery will be represented.

The final program of the Congress will present an ample and carefully arranged schedule of operative clinics, demonstrating the technique of a wide variety of surgical procedures, and will include a series of demonstrations at the medical schools and the larger hospitals for the presenta-

tion of work being done in many special branches of surgery, such as fractures, cancer, traumatic surgery, neurosurgery, plastic surgery, orthopedics, etc. The program will be so arranged that the visiting surgeon may be assured of the opportunity to devote his time continuously, if he wishes, to clinics dealing with those subjects in which he is most interested.

Programs for a series of scientific sessions, symposia and conferences, to be held daily at headquarters at the Waldorf-Astoria Hotel, are being prepared by the Executive Committee of the Board of Regents. On Monday evening the retiring president, Dr. Frederic A Besley, will deliver the presidential address, and the new officers will be inaugurated: Dr. Howard C Naffziger, San Francisco, president; Dr. Vernon C David, Chicago, first vice president; Dr. Fraser B Gurd, Montreal, second vice president. The 1938 class of initiates will be received into Fellowship at this session. Eminent surgeons of the United States and Canada and a number of visiting surgeons from foreign countries will present and discuss papers dealing with surgical subjects of timely importance at these sessions. Other features of the program for the Congress include a number of conferences and symposia dealing with fractures, cancer, obstetrics and gynecology, urology, neurosurgery, traumatic surgery, thoracic surgery, etc.

In addition to an extensive schedule of operative clinics and demonstrations at the hospitals and schools prepared by the subcommittees on ophthalmological and otolaryngological surgery, programs are being prepared for evening sessions for these sections on Tuesday and Thursday evenings at the Waldorf-Astoria Hotel, at which visiting ophthalmologists and otolaryngologists will present and discuss papers of special interest to those who practice these specialties.

The annual hospital conference will open the Congress with a session in the Ball Room of the Waldorf Astoria at 10 o'clock on Monday morning, at which a complete report on the college plan for graduate training in surgery will be presented. On Monday afternoon and on Tuesday, Wednesday and Thursday, both morning and afternoon an interesting program of papers, round table conferences and practical demonstrations, dealing with many problems related to hospital efficiency is being prepared. It is planned to make this year's session of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives, particular emphasis being directed toward professional standards and the vital problems related to hospital economics.

Headquarters for the Congress will be established at the Waldorf Astoria Hotel, on Park Avenue between 49th and 50th Streets, where the Grand Ball Room and large adjacent foyers, the Astor Gallery, Jade and Basilidon Rooms, all on the third floor of the hotel, have been reserved for Congress headquarters—for scientific sessions and conferences, and for the scientific and technical exhibits.

The technical exhibition, together with the registration and clinic ticket bureaus will be located in the east foyer, Astor Gallery, Jade and Basilidon Rooms, all on the third floor of the hotel. The bulletin boards, on which the daily clinical program will be posted each afternoon for the following day, will be placed in these rooms. Leading manufacturers of surgical instruments, x-ray apparatus, sterilizers, operating room lights, ligatures, dressings, hospital apparatus and supplies of all kinds, pharmaceuticals and publishers

of medical books will be represented in this exhibition.

The hospitals and medical schools of Greater New York afford accommodation for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics. The limit of attendance will be based upon the result of a survey of the operating rooms and laboratories of the hospitals and medical schools, to determine their capacity for visitors. It is expected therefore that those surgeons who wish to attend the Congress will register in advance. A registration fee will be required of surgeons attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the Congress. To each surgeon registering in advance a formal receipt will be issued which is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card is not transferable and must be presented in order to secure clinic tickets and admission to scientific sessions. The registration fee for Fellows and endorsed junior candidates is \$5.00, except that no fee will be required of local Fellows participating in the program and inmates of the class of 1938. For all others, invited as guests of the Clinical Congress, the fee will be \$10.00.

Admittance to the clinics and demonstrations will be controlled by means of special clinic tickets, such plan providing an efficient means for the distribution of the visiting surgeons among the several clinics and insuring against overcrowding the number of tickets issued for any one clinic being limited to the capacity of the room in which the clinic is given.



A



B



C



D

PLATE I

Inflamed Spreading Peritonitis Complicating Acute Perforative Appendicitis
 John O. Bowler M.D. F.A.C.S. John C. Burns M.D. and Harold A. Mengle M.D.
 (See legends on opposite page.)

SURGERY

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INDUCED SPREADING PERITONITIS COMPLICATING ACUTE PERFORATIVE APPENDICITIS

JOHN O BOWER, M D, F.A.C.S., JOHN C BURNS, M.D., and HAROLD A MENGLE, M D,
Philadelphia, Pennsylvania

PERITONITIS causes 92 per cent of the deaths of patients admitted to hospitals with a diagnosis of acute appendicitis. Of these deaths, according to the surgeons who operated or the physicians who wrote the gross findings, ¹ 81.7 per cent were due to spreading peritonitis, 10.4 per cent to local peritonitis, and 7.9 per cent to other causes. Deaths under the caption "Due to Other Causes" will not be discussed—the number is practically constant from year to year and includes catastrophes, deaths due to anesthetics, hemorrhage, cardiac dilatation, embolism, atelectasis, pneumonia, etc.

Deaths under the caption "Local Peritonitis," however, will be discussed in detail. Of each 100 patients admitted to hospitals with a diagnosis of acute appendicitis, between 15 and 20 have a localized abscess. These patients are usually operated upon within 24 hours, following operation, however, a number far in excess of what the average surgeon would consider moderate, develop hyperpyrexia or tachycardia and some of them die. A careful study of the clinical rec-

ords of these patients shows that those who recovered had a stormy and protracted convalescence. The cause of death written by the interne was, with very few exceptions, local peritonitis, the diagnosis on admission. We call this Group I—Operative-Induced Spreading Peritonitis.

A second group of patients, approximately 89 per cent of those admitted to the hospital with spreading peritonitis complicating acute

Plate I. A, Normal peritoneal cavity, living dog. Note large left lobe of liver; robin's egg blue of gall bladder; visceral peritoneum, light pinkish gray; parietal peritoneum, ileum, pinkish gray, omentum uniformly distributed covering large and small intestine. B, Twenty-four hour local peritonitis, no laxative. Appendix and mesentery ligated. Demonstrates omental quarantine of distended gangrenous appendix. Visceral peritoneum slightly injected, parietal peritoneum, unprotected loops of ileum, show dark pink injection. C, Twenty-four hour spreading peritonitis, no laxative. Appendix and mesentery ligated, visceral peritoneum hyperemic; parietal peritoneum, ileum, injected, vessels prominent, slightly distended. Stomach vessels injected, slightly distended. Liver displaced upward; omentum uniformly distributed over viscera. Exudate seropurulent. D, Twenty-four hour peritonitis, laxative induced. Appendix and mesentery ligated and 30 cubic centimeters of castor oil given immediately after operation. Parietal peritoneum intensely injected, visceral peritoneum, ileum, compare with lower left, loops distended in upper abdomen, stomach injected, marked increase in size of gastro-epiploic vessels. Omentum attempting to localize process, it extends from left lower to upper right between coils of ileum, exudate purulent.

From the Department of Surgical Research, Temple University Medical School—Philadelphia General, Temple University, St. Luke's & Children's and Northeastern Hospitals.

¹From the analysis of 18,687 cases admitted to 28 hospitals in Philadelphia over a period of 6 years.

perforative appendicitis, had received one or more than one laxative. The mortality of this group of patients was 115 per cent higher than that of the group that had not received laxatives. This is Group II—Laxative Induced Spreading Peritonitis.

Deaths in a third group of patients occurred because of a reactivation of the infectious process induced through errors in judgment in the management following operation. This is Group III—Postoperative Induced Spreading Peritonitis.

GROUP I—OPERATIVE INDUCED SPREADING PERITONITIS

Factors mainly responsible for its induction are

- 1 Failure to diagnose before operation the localizing process,
- 2 Failure to recognize the localizing process at operation,
- 3 Radical surgery.

1 Failure to diagnose before operation the localizing process. A clinical pathological classification of acute appendicitis and peritonitis based on correlation of symptoms and signs, gross findings at operation and what happens to the patient after operation will be reported elsewhere. The important addition to the generally accepted pathological classification—acute appendicitis, spreading peritonitis, and local abscess—is the localizing process, the potential or retrogressive spreading process.

Perforations of the appendix are either acute or subacute. The stage of transition between an intact serosa and perforation with spreading peritonitis in the acute fulminating type of appendicitis is minimal in point of time. The symptoms and signs however are usually consistently progressive, only occasionally because an excessive amount of antigen escapes through the perforation into the peritoneal cavity, do the symptoms and signs of perforation alone dominate the clinical picture. In subacute perforations, however, the symptoms and signs associated with rupture of the serous coat are minimal because the local tissue changes preceding and following it are designed by nature to limit the dose of antigen to an amount commensurate with the reactive

capacity of the patient. Before perforation the deposition of fibrin upon the serous coat swelling of the endothelial cells and the serous mobilization of neutrophils tend to thicken and strengthen the wall of the appendix. These changes are accompanied by an increase of intra appendiceal pressure which continues as long as the serous coat remains viable. When the cells composing this membrane die, the serous coat becomes separated from the gangrenous tissue beneath and intra appendiceal tension is diminished. At this point symptoms and signs previously present may disappear—it is the "lucid interval" (1). Absorption of antigen during this period is minimal. When perforation occurs because of liquefaction necrosis and increased intra appendiceal tension the spread of the process may be prevented by plastic exudate or by the parietal or visceral peritoneum or omentum. This is the localizing process (Fig. 1). The amount of antigen absorbed during this stage is also minimal. An analysis of this large number of clinical records shows that the average physician and surgeon invariably diagnose acute appendicitis and its chief complication, spreading peritonitis when the process is fulminant or moderately active, the same is true of the local abscess. The surgeon and his associates however frequently fail not only to diagnose the localizing process but certain lesions which frequently precede its formation as well—partial or complete gangrene of the appendix which, as we have previously stated, is responsible for the lucid interval. Every death that occurred from appendicitis and its complications on my service in 3 hospitals during the past 4 years was due to failure of the operator to diagnose these lesions before operation. The diagnosis of the localizing process before operation is dependent to a great extent upon a complete account, written in detail, of what happens to the patient before he is admitted to the hospital. This must include not only questioning the patient but the physician who first sees him as well which is especially important if the patient has had hypodermic injections. It should be emphasized that the physician who first sees a patient with an acute lesion of the abdomen whether immediately or potentially surgical

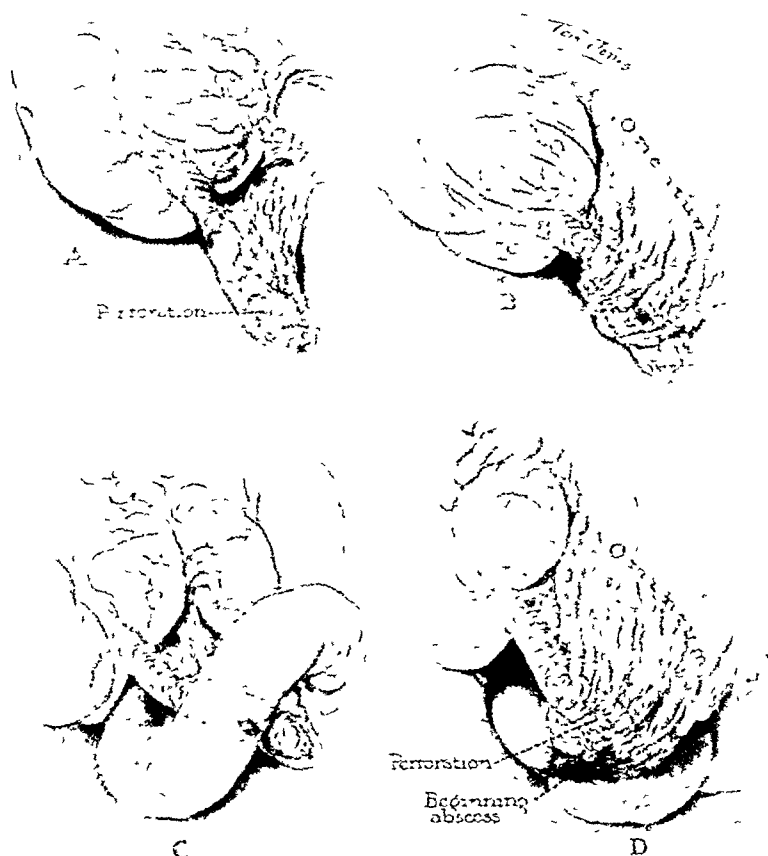


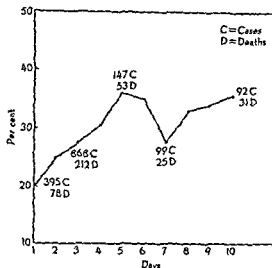
Fig 1

has the best opportunity to interpret correctly the tissue changes which have occurred intraperitoneally

Pre-operative diagnosis is also dependent upon a careful clinical study and repeated physical examinations after the patient is admitted to the hospital. The process usually begins in the mucosa, progressing to a partial or extensive gangrene or an acute suppurative process followed by necrosis, which accounts for the fact that early symptoms and signs are usually typical of an appendiceal colic of moderate degree. General colic-like pains which later localize to the right lower quadrant, nausea and one or two attempts at vomiting are the usual symptoms. The presence or ab-

sence of tenderness and tenseness or rigidity of the abdominal muscles depends on the situation of the appendix. During the first 24 hours the temperature is usually not higher than 101 degrees, pulse between 90 and 100, leucocyte count around 12,000 with a preponderance of neutrophils.

If perforation has been preceded by gangrene, the lucid interval which accompanies it may be confused with resolution by the attending physician, the relief of pain and the absence of tenderness and rigidity accompanying perforation are due to diminished intraperitoneal pressure; accompanying resolution, to the absorption of the products of inflammation in an intact appendix. A localiz-



Graph 1. Mortality of spreading peritonitis. 2,573 cases—24 hour groups 1925-1933

ing process in a resistant patient, when adequately Ochsnerized may be at times completely absorbed. It is not uncommon for a surgeon to remove an appendix while operating for another lesion, that shows definite evidence of a previous perforation. Ochsnerization instituted in the home is usually incomplete, enforced only to the point of cessation of acute symptoms. Frequently tenderness is present when fluids are given by mouth. The physician may send the patient to the hospital at this time but on admission signs of an acute process may have disappeared. Whether at home or in the hospital the prognosis is dependent upon whether a clinical pathologist is called in or whether something is given by mouth to stimulate peristalsis. If the clinical pathologist is consulted a catastrophe may be prevented if a laxative is given a frank spreading peritonitis invariably develop.

The diagnosis of a localizing process which is progressing to abscess formation is usually not difficult if the physician or surgeon is thinking of the possibility of its existence. A vaginal or rectal examination should be made in addition to the abdominal examination and the results of each recorded. A word of caution regarding repeated abdominal examinations

should be interpolated at this point. My associates and I have had the unpleasant experience of observing a rather obese female die following the conversion of a localized abscess into a spreading peritonitis by forceful manipulation. The safety of the patient is dependent in part upon repeated abdominal examinations but they should be done deliberately and carefully, the patient should be requested to co-operate, the physician explaining that the opening of the mouth and the bending of the knees facilitates relaxation. The entire hand of the examiner should be placed gently on the abdomen pressure being exerted only with the tips of the fingers.

2. *Failure to recognize the localizing process at operation.* Because of the gradual development of the localizing process, gross tissue changes are not marked, at least those visible through the average abdominal incision. The preperitoneal tissues are edematous and if the incision has been made over or near the lesion the parietal peritoneum will be injected—the degree of hyperemia of the visceral peritoneum will depend upon the time that has elapsed between perforation and operation. Free fluid, if present, is usually moderate in amount, cloudy, seropurulent, and slightly odorous. A smear may show micro-organisms, cultures frequently do. If rupture occurs in an appendix which has previously been involved in an infectious process, the accompanying appendiceal fibrosis and periappendiceal adhesions diminish absorption, and hyperemia of the peritoneum and transudation of fluids will be comparatively less. If the process is in close proximity to the incision it can be visualized and recognized without difficulty. Coils of distended small intestine cecum or thickened omentum however, may make visibility difficult. Perhaps the most important pathological finding which may lead one to suspect a concealed perforation is the marked thickening of the omentum caused by the increased vascularity edema neutrophilic and clasmatic infiltration. The foregoing is all that can be seen through a transverse or muscle splitting incision.

3. *Radical surgery.* A surgeon's mortality percentage is dependent to a great extent not only upon the number of cases he has managed

but on whether he has profited by the mistakes he has made as well. Without exception, there is no lesion of the abdomen requiring surgery in which errors of commission influence mortality so markedly as in spreading peritonitis complicating acute perforative appendicitis. Errors of omission are not so death dealing—if the patient with a localized abscess is left alone, he may absorb it—50 per cent of the dogs with appendiceal abscess following induced gangrene do. The old controversy as to whether immediate operation should be done or watchful waiting instituted has been definitely settled, in my opinion. Individuals recover or die from spreading peritonitis just as they do from a pneumonia or a spreading cellulitis because they do or do not develop a general and local tissue immunity. Doses of antigen, clasmatoctytic response, and antitoxin formation are as important in one as the other.

Graph 1 shows the mortality of 2,573 patients operated upon for spreading peritonitis following a perforated appendix. They have been divided into 24 hour groups—the vertical column shows mortality percentage; the horizontal line shows the day of the disease. You will observe that the mortality increases with each 24 hours up to the fifth day—there is a slight decrease on the sixth and a marked drop on the seventh day because general and local tissue immunity approach their maximum at that time. We have not found antitoxin in the blood of patients before the sixth day following perforation.

The important point in this discussion is the character of the reaction and the outcome of patients who are operated upon during the localizing stage. While the McBurney or muscle-splitting incision is made in less than 50 per cent of the acute cases, we will suppose that the operator suspects the possibility of rupture and that he selects this type of incision for obvious reasons. The peritoneal cavity reveals in part the gross findings described, but loops of intestine obstruct the surgeon's view. A small gauze pack is inserted and he attempts to quarantine the suspected process which he finally accomplishes but his vision is limited because of the small incision; after enlarging it, visibility is still only about

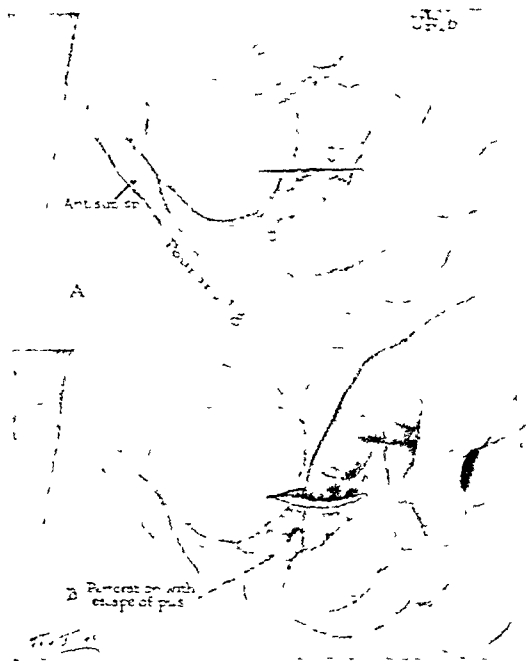


Fig. 2.

70 per cent. He is not sure whether the tip of the appendix adherent to the parietal peritoneum near the brim of the pelvis and surrounded by a loop of ileum is or is not perforated. Finally he separates the adherent tip from the peritoneum and purulent material exudes. The peritoneum has been well prepared for rapid absorption of antigen. Loops of ileum have been separated, fibrinous plaques have been brushed off, endothelial cells have been destroyed, exposing capillaries and lymph vessels. If at this point a drain is inserted, the gauze strips gently removed, a normal saline dressing applied and Ochsnerization instituted, 9 out of 10 patients will successfully combat the dose of antigen. But now that the operator has started he wants to finish the job and he removes the appendix. In a large number of instances death follows.

Perhaps the surgeon has not followed the procedure described; perhaps he has done something worse—not being able to visualize the process he may have placed an index finger into the wound and attempted to hook up the appendix—Figure 2 shows definitely what happens. One-twenty-millionth gram of crys-

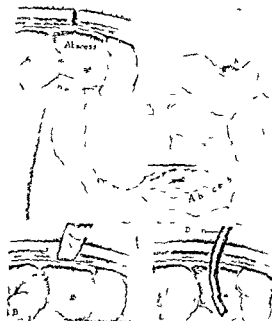


Fig 3

talline egg albumen is sufficient to stimulate antibody formation. How much antigen escapes into the peritoneal cavity from the average ruptured appendix? How much is absorbed from this gauze abraded area? This cannot be estimated at operation but the immediate postoperative response of the patient will tell—perhaps he will respond satisfactorily—80 per cent of them do but 20 per cent of them do not.

While the mortality of the localizing process is high, when the appendix is removed in the presence of a spreading process the mortality is still higher. Table I shows what occurred in 12 of the 18 hospitals in Philadelphia where radical surgery was practiced. The average time between onset of symptoms and operation was 56 hours; the mortality 37.4 per cent; the appendix was removed in 93.7 per cent of instances.

THE PREVENTION OF OPERATIVE INDUCED SPREADING PERITONITIS

Anesthesia. When the patient is a good spinal anesthesia risk, and the anesthesiologist has had experience in the technique of induction

TABLE I

H. P.	Spread of peritonitis			Appendix removed per cent	Average hours onset of symptoms and operation	
	Cases	Deaths	Mortality per cent		Recovery %	Deaths
1	1	4	40	77.7	64	11.7
10	4	1	25	100	37.6	14
12	21	5	23.8	100	50.4	23.7
15	12	8	66.6	90	61	66
7	3	2	100	100	9	97
19	39	11	28.1	100	60.9	9
21	25	4	16.0	100	59.6	51.2
2	21	7	33.3	95	61.5	5
24	7	2	28.5	100	45.7	14
2	17	8	46.5	80	71.9	97
10	20	10	50	63	4.9	54.7
28	8	3	37.5	100	35	75
	171	64	37.4	93.7	57 hrs	35.4 hrs

and the management of patients who have had spinal anesthesia, it is ideal for opening an appendiceal abscess. The surgeon or anesthesiologist endeavoring to develop a spinal technique should not include patients with spreading peritonitis. If the diffusion of the anesthetic is too high and artificial respiration is resorted to, or carbon dioxide with oxygen is given under pressure, the excursions of the diaphragm and the passive movements of the accessory muscles of respiration will diffuse the process and increase absorption.

Advantages of spinal anesthesia are

1. The accessory muscles of respiration and the transverse abdominal muscles are relaxed thus permitting a maximum of visualization of the peritoneal cavity in addition absorption is diminished because of the minimal excursions of the diaphragm and anterior abdominal wall.

2. The abscess can be outlined accurately by palpation and at times can be seen protruding above the normal contour of the abdomen.

3. The relaxed and more quiet abdomen permits a better preperitoneal palpation of the intraperitoneal abscess (see technique, Fig 3B).

Spinal anesthesia increases peristalsis. In early spreading peritonitis adherent loops of

intestine may be separated, which we have shown by cinema, taking place in the peritoneal cavity of dogs. The greater ease of accessibility diminishes the likelihood of rupturing the abscess wall which, in my opinion, more than offsets the effect of the toxemia induced by the increase in peristalsis produced by the spinal anesthesia.

Abdominal incision and preperitoneal palpation. The location and type of incision are determined by the situation of the abscess. In all instances an attempt is made to open the abscess from the roof. The advantage is twofold—drainage is simple and absorption is minimal, a single rubber tube only being required (Fig. 3C).

Figure 3 shows the method employed when the transverse incision is used. Following separation of the fibers of the internal oblique and transversalis muscles, the index finger palpates the mass beneath, no attempt being made to aspirate (Fig. 3B). If it is tense and resistant to the touch, the peritoneum is opened and a drainage tube is inserted into the abscess (Fig. 3C). Two small cigarette drains may be inserted, one on either side of the tube, to control oozing and permit the gradual withdrawing of the tube, thus reducing absorption to a minimum. The wound is not sutured, a safety pin is pierced through the tube and gauze is placed above and below so as to insure its being securely anchored by the retentive bandage.

When preperitoneal palpation with the index finger discloses a non-resisting mass (Fig. 4A), intestinal coils are undoubtedly present beneath, and another attempt should be made to locate that portion of the abdominal wall which the operator considers a more direct route to the roof of the abscess. Another incision is made and preperitoneal palpation again carried out. If it is located the first incision is closed and a tube inserted through the roof (Fig. 4B). If the surgeon discovers intestinal coils instead of an abscess, after the peritoneal cavity is opened, he should carefully insert his index finger and locate the wall, another incision should then be made over the roof after the first incision is closed, if the abscess cannot be definitely located by this method, the patient should be returned

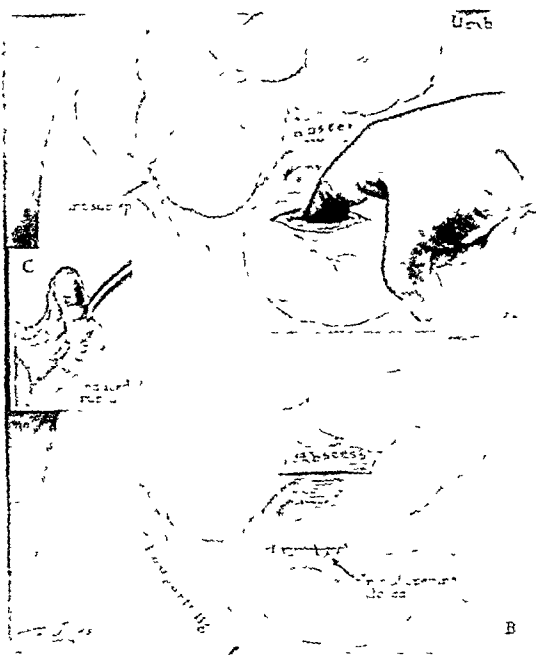


Fig. 4

to the ward for further observation and Ochsnerization continued—frequently this type of abscess will be absorbed and appendectomy can be carried out at the end of 8 weeks.

Removal of appendix. The appendix is not removed in the presence of a localized abscess, or when an unsuspected localizing or spreading process is found at operation. The only exception to this is in spreading peritonitis when there is no evidence of localization and the perforated appendix is accessible, it is removed and a catheter is placed in the cecum.

The following abstract with graphic illustration (Graph 2) shows how a spreading peritonitis *should not* be managed.

Female, aged 21 years, had symptoms and signs of an acute surgical abdomen. "Results" (laxative) given 5 hours after onset of pain. Patient was admitted to the hospital and operated upon 30 hours after onset of symptoms, anesthetic spinal novocaine and local novocain. A right rectus incision was used. The appendix was retrocecal, and perforation was not recognized immediately. The appendix was removed and multiple drains were inserted. Eighty cubic centimeters of perfringens antitoxin in divided doses was given intramuscularly, glucose metabolic balance instituted; death in 5 days.

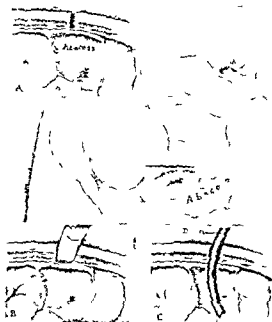


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10	4	1	25	100	55.6	14
12	21	3	14.3	100	50.4	70.2
15	4	3	60.0	90	4	21
17	3	2	100	100	0	67
9	30	11	36.7	100	69.0	41
21	15	4	26.7	100	50.2	33.3
22	21	7	33.3	95	61.5	60
24	7	2	28.6	100	48.7	11.4
25	17	8	47.1	80	71.0	91
26	20	10	50	91	49.0	54.2
28	3	2	66.7	100	33	75
74	64	37.4	58.4	93.7	57 hrs	37.4 per cent

and the management of patients who have had spinal anesthesia, it is ideal for opening an appendiceal abscess. The surgeon or anesthesiologist endeavoring to develop a spinal technique should not include patients with spreading peritonitis. If the diffusion of the anesthetic is too high and artificial respiration is resorted to, or carbon dioxide with oxygen is given under pressure the excursions of the diaphragm and the passive movements of the accessory muscles of respiration will diffuse the process and increase absorption.

Advantages of spinal anesthesia are

1. The accessory muscles of respiration and the transverse abdominal muscles are relaxed, thus permitting a maximum of visualization of the peritoneal cavity in addition absorption is diminished because of the minimal excursions of the diaphragm and anterior abdominal wall.

2. The abscess can be outlined accurately by palpation and at times can be seen protruding above the normal contour of the abdomen.

3. The relaxed and more quiet abdomen permits a better preperitoneal palpation of the intraperitoneal abscess (see technique, Fig 3B).

Spinal anesthesia increases peristalsis. In early spreading peritonitis adherent loops of



A



B



C



D

PLATE II

Induced Spreading Peritonitis Complicating Acute Perforative Appendicitis
John O Bower, M D , F A C S . John C Burns, M.D , and Harold K Mengle, M D
 (See legends on opposite page)

A spreading process was suspected but was not definitely diagnosed before operation. Spinal anesthesia was unsatisfactory. Death was due to two large doses of antigen, laxative before operation and search for and removal of appendix. Too radical surgery.

The following abstract with graphic illustration (Graph 3) shows how a *localizing process*—a laxative induced retrogressing process—should be managed.

Female aged 17 years had symptoms and signs typical of spreading peritonitis. Citrate of magnesia was given 24 hours after the onset of symptoms. Patient was admitted to the hospital 72 hours after the onset of pain. She was given 100 cubic centimeters of perfringens antitoxin intramuscularly in 3 doses and continuous hypodermic of normal saline. Patient held 5 days before operation. Spinal anesthesia neocaine was used. Through a transverse incision the *localizing process* was recognized but not disturbed. A cigarette drain was inserted down to, but not into the abscess cavity. Drain was removed on fifth postoperative day. Subsequent operation on nineteenth day after onset of symptoms—14 days after first operation—showed complete absorption of the appendix.

Glucose should have been given with the normal saline solution. A gauze drain would not have been necessary. Good judgment was shown in not disturbing a localizing process. One dose of antigen.

The following abstract with graphic illustration (Graph 4) shows the results of the failure to diagnose before operation the localizing process, and the disastrous results induced by simple drainage.

Male aged 22 years had symptoms and signs typical of acute appendicitis. An Ex lax tablet was given immediately after the onset of pain. Patient was admitted to the hospital 48 hours after onset of symptoms and was operated upon immediately. Spinal anesthesia neocaine was given. A transverse incision was made. The localizing process was not recognized until the pus exuded retroceally. The appendix was not removed. Rubber tube and cigarette

drains were inserted—gauze quarantine drain was removed. Thirty cubic centimeters of perfringens antitoxin was given immediately and again in 24 hours intramuscularly. An attempt was made to maintain the glucose metabolic balance. Symptoms and signs of spreading peritonitis diminished but patient developed pneumonia and died on twelfth postoperative day. Postmortem showed localized peritonitis.

This patient received two doses of antigen laxative before operation plus search for and opening of abscess. He should have been held until a localized abscess had developed.

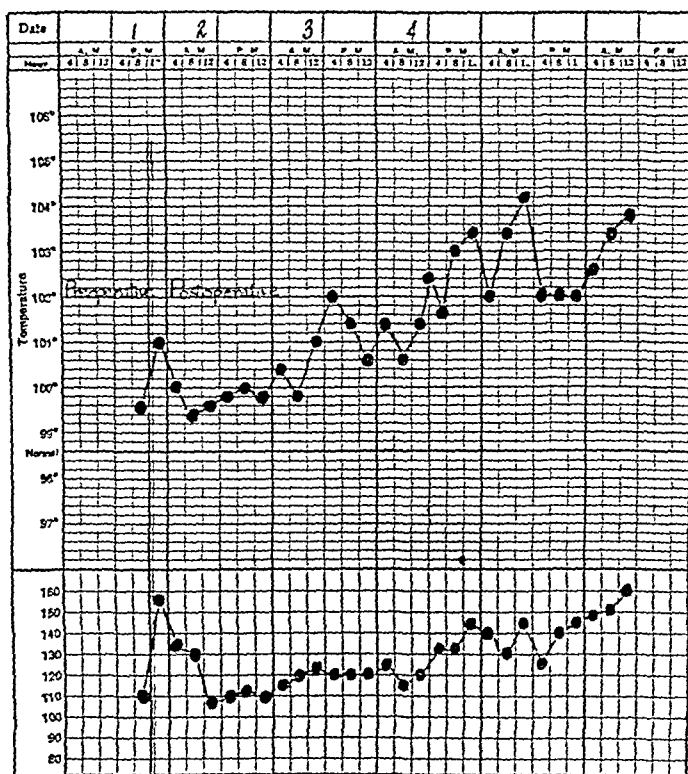
GROUP II—LAXATIVE INDUCED SPREADING PERITONITIS

Of the 2,578 patients admitted to hospitals in Philadelphia with spreading peritonitis complicating acute perforative appendicitis, 1,406 gave definite statements regarding laxative administration, 89.14 per cent had received laxatives. In this same group 153 had not received laxatives and 16, or 10.43 per cent, died, 1,119 received one laxative and 250, or 22.34 per cent, died, 136 received more than one laxative and 33, or 28.67 per cent, died.

These observations are not new, surgeons have known for many years that laxatives increase the incidence of spreading peritonitis and interfere with the possibility of localization, not only in perforation of the appendix but in acute lesions involving other abdominal viscera. Heretofore there has been no definite evidence, however, to show that a laxative induced spreading peritonitis differs pathologically from a spreading peritonitis when laxatives have not been given. An inspection of the colored photographs (Plates I and II) will show more than any number of words can describe, the difference between spreading peritonitis that has and has not been induced

Plate II. A. Forty-eight hour spreading peritonitis no laxative. Appendix and mesenteryligated parietal peritoneum upper left normal color. Visceral peritoneum ileum blood vessels more prominent loops nearest focus of infection brilliant red stomach normal color omentum lower right localized over perforated appendix exudate serous slightly cloudy. B. Forty-eight hour laxative induced spreading peritonitis. Thirty cubic centimeters of castor oil given immediately after ligation of appendix and mesentery parietal peritoneum light to dark mahogany visceral peritoneum, compare with upper left omentum not localized lighter area in center crossed by large mesenteric veins left to right exudate hemorrhagic purulent. C. Seventy

two hour spreading peritonitis no laxative. Appendix and mesentery ligated, parietal peritoneum more injected than upper right visceral peritoneum ileum injected loops adherent, slightly distended stomach not visible omentum mobilized around the perforated appendix in left midabdomen exudate hemorrhagic. D. Seventy-two hour laxative induced spreading peritonitis. Thirty cubic centimeters of castor oil given immediately after ligation of appendix and mesentery parietal peritoneum dark red due to venous congestion visceral peritoneum, ileum lusterless no serbation of normal intestine loop in hypergastric region cyanotic. Omentum disintegrated beginning necrosis exudate dark purulent.



Graph 2 Pulse and temperature charts in case of F. S. showing how a spreading peritonitis should not be handled

by laxatives. These photographs of the dog's peritoneal cavity were made before death of the animal: clinical investigations as well as our experimental work show that if man is treated similarly to these dogs he has 3 chances in 8 of dying in the same fashion

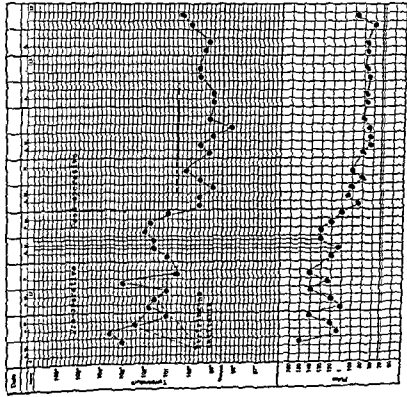
EXPERIMENTAL WORK

A summary of the experimental work conducted by Drs J. C. Burns, H. A. Mengle and myself in the Department of Surgical Research, Temple University, is appended

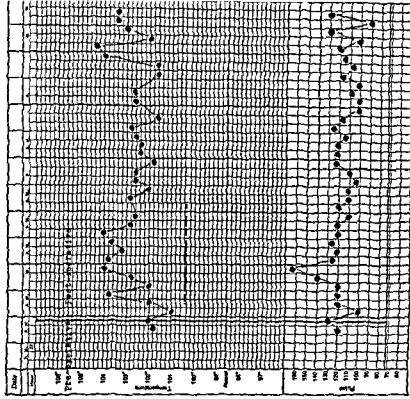
We ligated the base and mesentery of the appendix in a group of dogs. Fifty per cent of them developed a localized abscess and recovered and 50 per cent died of spreading peritonitis. In a second group of 54, the base of the appendix and the mesentery were ligated, 30 cubic centimeters of castor oil was given 24 hours after ligation and 68 per cent died of spreading peritonitis. To a fourth group of 12, 54 cubic centimeters of castor oil was given immediately after operation and 91 per cent died of spread-

ing peritonitis. In a fifth group the appendix and its mesentery were ligated; laxatives administered. The animals were re-operated upon at varying periods of time and the peritoneal exudate studied bacteriologically. These findings, and the results of a study of the bacterial flora obtained from patients operated upon for spreading peritonitis complicating acute perforative appendicitis, together with a review of the literature have been reported (2). Our investigations showed that the aerobic bacterial flora in man and dog differed in that the colon bacillus was found only in 14 per cent in the dog as compared with 68 per cent in man. A study of the anaerobic flora showed that the *Clostridium welchii* was present in 60 per cent of instances in man and 63 per cent in the dog. These figures are practically the same as those of Weinberg.

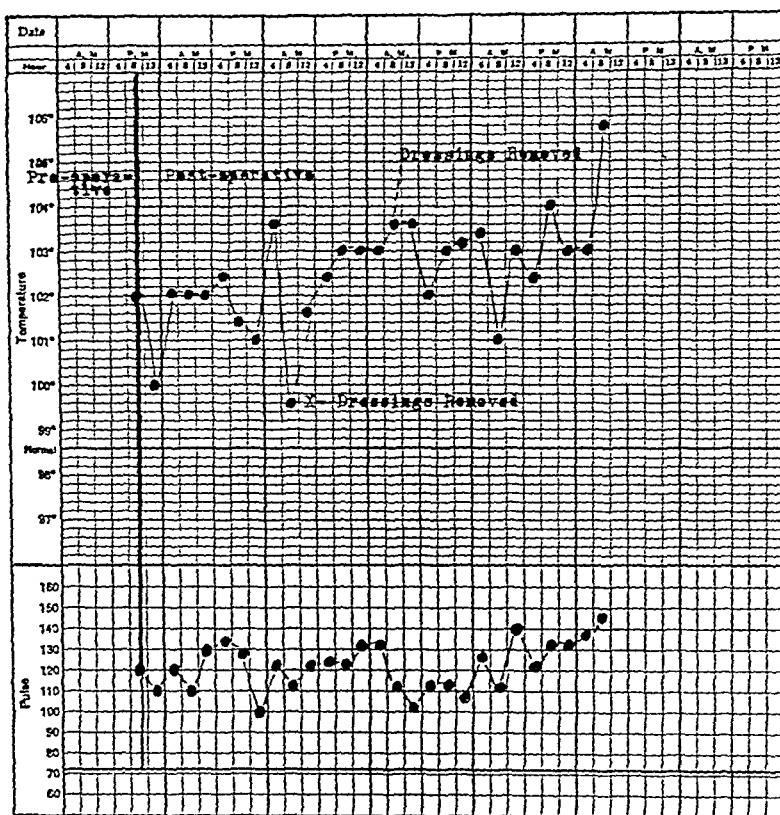
We then treated dogs that had an induced spreading peritonitis with perfringens antitoxin (*Clostridium welchii*). The mortality of the control group—89 dogs—was 74 per cent; of the treated group, 38 per cent. A second group was given horse serum—the mortality was 60 per cent, in a third group perfringens antitoxin combined with whole blood was given, mortality 33 per cent, in a fourth perfringens antitoxin combined with *Bacillus coli* serum, mor-



Graph 3. Pulse and temperature charts in case showing how localizing process should be managed



Graph 4. Results of failure to diagnose the localizing process and of the use of drainage



Graph 5 Effect of too early removal of drains

tality 33 per cent, in a fifth, perfringens antitoxin combined with immune serum, mortality 33½ per cent, and finally lyophilized convalescent serum (serum removed from dogs that had recovered from a laxative-induced spreading peritonitis) was injected, in this group we obtained the lowest mortality—25 per cent (to be reported in detail elsewhere, 3). Following this animal experimentation, two groups of patients, over 90 per cent of whom had received laxatives and had had a frank spreading peritonitis due to a perforated appendix, were studied. They had been treated with perfringens antitoxin. The first group is made up of 31 patients who had been operated upon directly after admission, average 61 hours, and given perfringens antitoxin and glucose intravenously—with a mortality of 19.35 per cent. A second group, 35 patients, had been held and given perfringens antitoxin and glucose intravenously, localized abscess opened on seventh day—the mortality was 57.1 per cent.

Up to this point, we have shown that—

1 The incidence as well as the mortality of spreading peritonitis in both man and dog

were increased by the administration of laxatives;

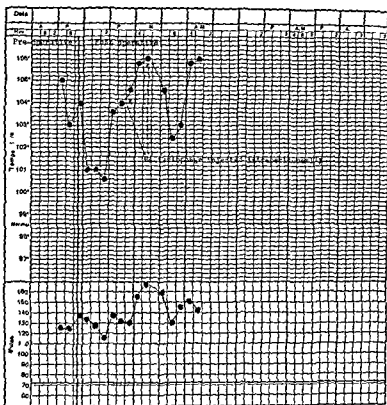
2 The time of administration and the dose of laxative influenced the mortality;

3 The *Clostridium welchii* was present in 60 per cent of instances in the flora of spreading peritonitis in man and dog;

4 The administration of perfringens antitoxin reduced the mortality of spreading peritonitis 122.52 per cent in man and 94.74 per cent in the dog;

5 Convalescent serum, lyophilized, was a factor in the low mortality of spreading peritonitis in both man (to be reported) and dog.

There remained but one discovery necessary to establish the proof and that was to find the antitoxin of the *Clostridium welchii* in the blood of patients who had recovered from spreading peritonitis due to a perforated appendix. This has been reported (4).



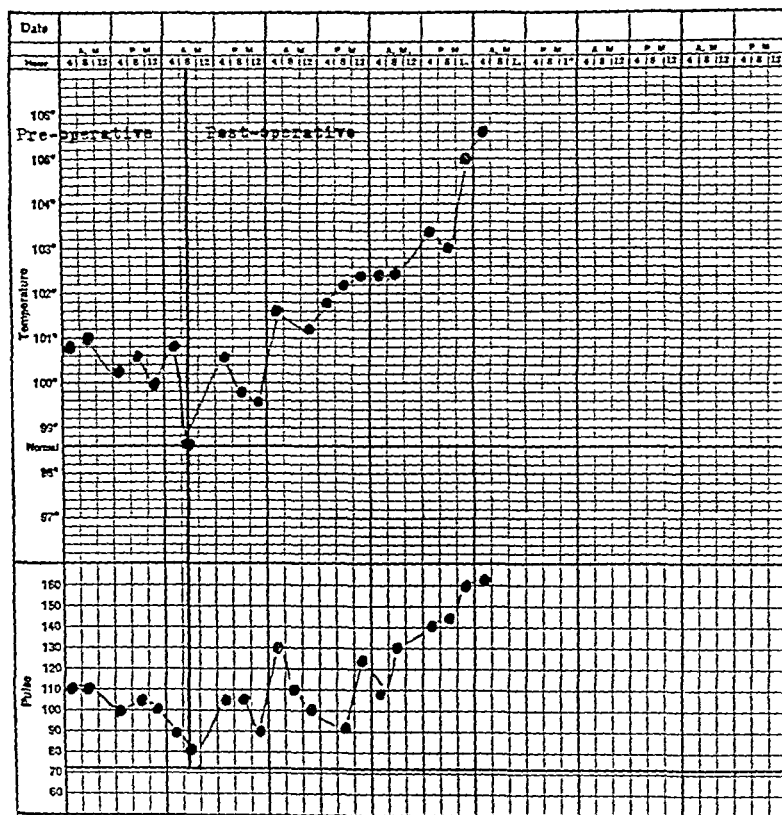
Graph 6 Effect of meddlesome postoperative management

Using the technique required by the National Institute of Health pigeons weighing 350 grams were injected with a lethal dose of *Clostridium welchii* toxin—0.013 gram and 1 cubic centimeter of perfringens antitoxin, all of the control pigeons died. One cubic centimeter of serum obtained from individuals in a normal state of health was then injected with the *Clostridium welchii* toxin antitoxin mixture into 28 pigeons, they all died. In another group 1 cubic centimeter of serum obtained from patients who had recovered from simple appendicitis was injected with the *Clostridium welchii* toxin antitoxin mixture 23 died and 2 lived. In another group serum obtained from patients suffering with peritonitis due to a pelvic infection was injected into 33 pigeons 25 died and 8 lived. Finally 63 pigeons were injected with the lethal dose of *Clostridium welchii* toxin antitoxin mixture and serum obtained from patients who had recovered from spreading peritonitis due to a perforated appendix, 46 per cent of them lived and 54 per cent died. Antitoxin of the *Clostridium welchii* was present in 75 per cent of the patient serum—18 of 24. In addition to these tests convalescent lyophilized serums that had been removed from man and dogs and had been standing at room temperature for 465

days were injected into pigeons and found to contain antitoxin of the *Clostridium welchii*.

GROUP III—POSTOPERATIVE INDUCED SPREADING PERITONITIS

In another communication the senior author has emphasized the importance of 'Management of Spreading Peritonitis Due to a Perforated Appendix' (6). A disease with a recognized mortality of from 27 to 45 per cent can be successfully treated only by those who have previously managed similar cases. From the time of admission until the patient has successfully overcome the usual maximum dose of toxins conferences should be held between surgeon in chief, associates, and surgical residents. Had this been done routinely, on the services on which the following patients were treated catastrophes would not have occurred. The following abstract with graphic illustration (Graph 5) shows what may happen when drains are removed too early.



Graph 7 Effect of use of peristaltic stimulants after operation

Male, aged 15 years, had symptoms and signs of spreading peritonitis following a perforated appendix. Castor oil was given immediately after onset of symptoms. Nitrous oxide-ether anesthesia was used. Through a transverse incision, the appendix was removed, and saline and glucose were given after operation. No perfringens antitoxin was given. Drains were removed at the end of 24 and 48 hours, respectively.

Four doses of antigen were given as well as a laxative before operation. Appendix was removed at operation, the drains were removed 24 hours and 48 hours after operation.

Meddlesome postoperative management is shown in this abstract and Graph 6.

Female, aged 21 years, had symptoms and signs typical of spreading peritonitis complicating acute perforative appendicitis. Physician prescribed laxative immediately after onset of pain. Operation was performed 45 hours after the onset of symptoms. Spinal anesthesia, neocaine, was used. A transverse incision was made, and the appendix removed. Twelve hours after operation 1 cubic centimeter

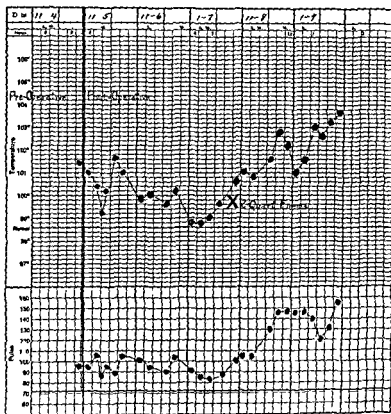
bacteriophage and 100 cubic centimeters of normal saline were introduced through drainage tube into the peritoneal cavity.

Three doses of antigen, a laxative before operation, then removal of appendix at operation, and injection of bacteriophage and saline, after operation, are the factors in this case.

The postoperative use of peristaltic stimulants is shown in this abstract with Graph 7.

Female, aged 61 years, had symptoms and signs typical of a spreading peritonitis complicating acute appendicitis. Epsom salts were given immediately after onset of symptoms. The physician gave morphine before diagnosis was made. Operation was performed 92 hours after onset of symptoms. The anesthetic, neocaine, spinal. A transverse incision was used and the appendix removed. Immediately after operation patient was given fluids by mouth and 3 doses of pitressin.

In this case, 4 doses of antigen were given, a laxative given before operation, then the appendix was removed, and water and pitressin were given after operation. This death cannot be attributed to pitressin alone, but it is difficult to grasp the logic



Graph 8 Effect of enema after operation

of stimulating peristalsis thereby increasing absorption when nature is attempting to prevent absorption by diminishing peristalsis in every possible manner

Enemas and postoperative management are noteworthy in this case (Graph 8)

Male aged 25 years was admitted to the hospital with a diagnosis of acute fulminating appendicitis. Epsom salts were given 30 hours after the onset of pain. Operation was done 54 hours after onset of symptoms anesthetic neocaine spinal. A right rectus incision was used and a perforated appendix with spreading peritonitis was encountered. The appendix was not removed drainage instituted. Patient was given glucose intravenously and 80 cubic centimeters of perfringens antitoxin. Inspection of Graph 8 shows a favorable reaction until the nurse, by mistake gave him a 2 quart enema—the recurring spreading peritonitis caused his death 96 hours after operation. At autopsy the odor of acetone was still present in the peritoneal cavity.

Ten years after this patient's operation and death we were informed by an associate of what actually caused the death. The enema was ordered by the

resident physician for a patient in an adjoining bed. The associate then a resident in the hospital performed the autopsy.

SUMMARY

1 Of any 100 patients who die from acute appendicitis and its complications according to the cause of death on the patient's clinical records 81 per cent die of spreading peritonitis over 10 per cent of local peritonitis and 7.9 per cent of other causes.

2 An accurate analysis of the group 'local peritonitis' shows that a number larger than would be considered moderate by the average surgeon dies not from local peritonitis but from an operative induced spreading peritonitis. The cause of death in this group is the failure to diagnose the 'localizing process' before and to recognize it at operation. Notes on its recognition before and at operation, of the value of spinal anesthesia

and the advantages of preperitoneal palpation are appended.

3 Laxative-induced spreading peritonitis is described; colored photographs of the peritoneal cavity of living dogs contrasting the gross changes accompanying non-laxative and laxative induced spreading peritonitis are shown

4 The part radical surgery plays in the high mortality, especially the search for and the removal of the appendix in the presence of a spreading or a localizing process before local and general immunity have developed, is emphasized.

5 Brief abstracts of case histories showing how localizing or localized processes in post-operative induced spreading peritonitis were converted into spreading processes with fatal

terminations because of errors in management committed during the immediate postoperative period, are reported.

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ACUTE APPENDICITIS IN CHILDREN

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ALTHOUGH the diagnosis and treatment of acute appendicitis have been standardized to a degree, further improvement in the handling of cases must be attained if the mortality is to be still further reduced. Whether or not the mortality of acute appendicitis has been rising during the past decade, papers by Walker, Fitz, Bower, and others clearly show that the treatment of this disease has not been perfected. Certainly no one is justified in assuming a smug attitude of contentment in view of present mortality figures.

The most important factor in acute appendicitis in children is the rapidity with which the disease progresses. It is not uncommon to find a perforated appendix in a child who has been ill less than 12 hours. Advanced disease is encountered early most frequently in the two extremes of life. In a series of 100 cases in adults over 40 years of age reported by Maes, Boyce, and McFetridge, 77 per cent had gangrene, perforation, abscess formation, peritonitis or a combination of these complications. The mortality for the series was 21 per cent. The same authors report a series of 250 children with similar complications in 73 per cent, the mortality of this series was 7.6 per cent. Hudson, quoting the State of Massachusetts vital statistics, reports that appendicitis ranks eighth in importance among all causes of death for children between the ages of 1 and 9. In children the appendiceal structures are delicate and contain a large amount of lymphoid tissue. Also the great omentum is less developed, shorter, smaller and hence less efficient as a localizing and protective agent than it is in adults. In our own cases the omentum seldom aided in localizing the infection, and then only in a few patients over 10 years of age.

In this paper we are reporting a study of 235 consecutive cases of acute appendicitis in children 14 years of age and under. The cri-

terion used in the final diagnosis in these cases was the composite picture made by the history, physical examination, blood count, operative findings, and the pathological report. All borderline cases were listed as chronic and excluded from the series. All patients were operated upon.

The fact that procrastination on the part of parents and physicians, as well as the giving of cathartics, raises the incidence of perforation and the mortality of this disease is well proved and ably discussed by other writers. We feel no need of going over this well known ground. Rather we wish to present this series from the viewpoint of what is to be done for a child with acute appendicitis when the patient enters a hospital. The series is presented also for the purpose of comparing procedures and results with those of other clinics in the hope that by joining forces a general advance may be made against the disease.

Stone states that the general picture of appendicitis in children is similar to that in adults except that the mortality in children with peritonitis is higher—34 per cent as compared with 16 per cent in adults in his series. We agree that a similarity exists and we believe that the same criteria in history and physical examination should be used. Difficulties in diagnosis are three fold and are found most often in the young children, from whom it is difficult to obtain a history, in whom examination must often be made without the patient's co-operation, and in whom the laboratory findings may be misleading. White cells in the urine do not rule out acute appendicitis, in fact they frequently accompany an inflamed pelvic or retrocolic appendix. Moreover a greater number of atypical cases are found in children than in adults.

There are some definite aids to diagnosis, however, which should always be employed. The rectal examination is even more valuable in children than in adults because of the relatively greater distance the finger can reach. No examination is complete in the child un-

less a rectal examination has been done. Acute appendicitis is often seen in nearly an epidemic form. Evans showed that after an epidemic of acute upper respiratory infection a wave of appendicitis will follow, the average interval in a given case being 16 days, the extremes being 1 to 60 days. Stone finds his greatest frequency of acute appendicitis in children when gastro-intestinal upsets are most frequent. Our experience corroborates that of both these authors. It is our belief that appendicitis which follows a gastro-enteritis is not only difficult to diagnose, but it is often of the rapidly progressive fulminating type.

OPERATIVE PROCEDURES

In practically every paper on appendicitis the mortality in unruptured cases is very satisfactory. The patients with perforations are the ones likely to die; therefore the skillful care of such patients is one very fruitful method of lowering the mortality of appendicitis in children. Table I is a comparison of the mortality of perforation cases in the first 3 and the last 4 years of this series. The reason for this division is that the two periods offer a contrast in operative technique, fluid administration, and postoperative care, which we believe accounts for the difference in mortality rates. In the entire series the mortality in perforation cases was reduced from 16.3 to 6.5 per cent, while the percentage of perforation cases remained unchanged. In children under 6 the mortality fell from 33.3 to 17.6 per cent. This mortality figure of 17.6 per cent was obtained in the face of a greatly increased number of perforations: 85 per cent, as compared with 46.2 per cent for the first period.

The increasing use of the McBurney incision is one of the reasons, we believe, for this lowering of mortality.

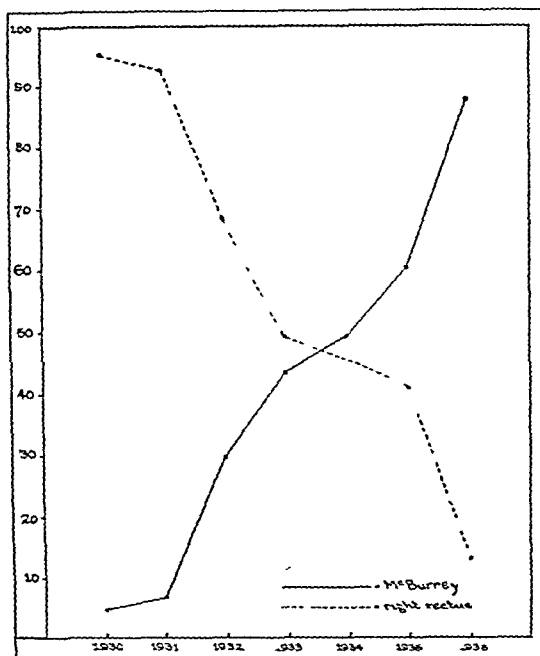


Chart 1 Showing increasing use of the McBurney incision in this series, from 5 per cent in 1930 to 87 per cent in 1936

Chart 1 shows the relative frequency of McBurney and right rectus incisions from year to year. There are four distinct advantages of the McBurney incision over the right rectus. It permits easy, direct access to the site of disease, minimizing any soiling of uninvolved peritoneum. Drains, when necessary, can be placed laterally. A McBurney incision can be closed loosely without great risk of postoperative hernia, and such closure is very important in the peritonitis cases. In drainage cases when the McBurney incision is employed only the peritoneum need be sutured. Postoperative wound complications, such as sloughing, infection or cellulitis of

TABLE I—MORTALITY IN PERFORATION CASES

Period	Entire series				Ages 1-5 inclusive			
	No cases	% Perforation	Deaths	% Mortality	No cases	% Perforations	Deaths	% Mortality
1930-1932	43	38.7	7	16.3	6	46.2	2	33.3
1933-1936	46	37.1	3	6.5	17	85.0	3	17.6
1930-1936	89	37.9	10	11.2	23	69.6	5	21.7

The figures in the percentage columns show the proportion of perforation cases in the series during the various time periods.

the abdominal wall are rarely seen. Lastly, when a secondary operation for obstruction is necessary, it can be easily performed by the right rectus route through uncontaminated structures if the primary operation was performed by the McBurney approach. For these reasons the McBurney incision is used almost exclusively.

The appendix should always be removed. The only cases in which this rule is not followed are those in the localized abscess group. Merely to drain in cases of appendiceal peritonitis is not logical, for what will prevent the continued pouring out of septic and fecal material from the diseased organ into the free peritoneal cavity? There is only one case in this series in which the appendix was not removed in the presence of peritonitis; this patient died, as is usually the case.

Drainage is used only when gross septic or fecal soiling is present or when exudate exists on the cecum, terminal ileum, or parietal peritoneum. The presence of fluid, even cloudy fluid, is no indication for drainage. When drains are used, they are used freely. A soft rubber tube is placed in the pelvis. One or two cigarette drains are placed below or lateral to the cecum. We believe that drains placed medially to the cecum increase the possibility of obstruction. Postoperative obstruction may occur in spite of placing the drains laterally, but then it is probably due to the terminal ileum falling against and adhering to the appendiceal bed. This complication can be minimized by placing a rubber sheet in the form of a cofferdam between the terminal ileum and the raw appendiceal bed. Usually it is necessary to pack a little gauze loosely in the cofferdam, care being taken to avoid contact between the gauze and the serosal surfaces. The cofferdam may be dispensed with in those cases in which all raw surfaces can be satisfactorily covered by omentum. On about the fourth postoperative day the drains should be loosened by twisting them. Depending upon the amount of drainage, cigarette drains may be removed by the fifth or sixth day. When three have been used, it is best not to remove more than one or two on a given day. When the cofferdam technique is used, the gauze packing is removed on the sixth or seventh

day. The rubber dam is not removed before the ninth or tenth day. The rubber tube is the most important drain of all and is removed last. This is done by shortening it a few centimeters on consecutive days, starting at about the sixth day. It usually comes out between the ninth and twelfth days. We cannot agree with Shipley's statement that drainage can be dispensed with in early peritonitis. When drainage is used, the wound is closed loosely about the drains. In some of the severer cases no sutures at all were placed in muscles, fascia or skin. The McBurney incision makes this possible.

When the base of the appendix and the cecum are involved, i. e., when the appendiceocecal junction is indurated or friable, cecostomy as an auxiliary procedure is of great benefit. This procedure is also indicated in peritonitis when the bowel is greatly distended, and it is far more effective than late enterostomy. The tube is placed directly through the appendiceal stump and when possible through the ileocecal valve, extending into the terminal ileum. In this series it was used in 4 cases: in 2 because the cecum was involved and closure would have been difficult, and in 2 because of peritonitis with great distention of the large bowel. In these 4 cases the catheter was removed at about the eleventh day, and all the wounds healed promptly.

Although a few operations were performed under local and spinal anesthesia, nitrous oxide induction followed by ether was the method generally used. We look forward to appraising the effect of the newer gaseous anesthetics on mortality and morbidity.

Most of the patients were operated upon immediately after admission. In a few cases operation was delayed. These children were all extremely ill. They showed generalized abdominal tenderness, moderate general rigidity, marked distention and peristaltic sounds could not be heard. All had the typical faces of peritonitis. In these cases the Ochsner-Deaver treatment was instituted. If improvement was noted in 12 hours, the treatment was continued; if not, operation was performed. By postponing operation in these cases we feel sure that a few were saved who would not have survived immediate operation. It must be

emphasized, however, that the cases in which delayed operation is indicated in children are relatively few. Certainly Sir James Berry, who in his address "The Fallen Idols" pleads categorically and without qualification for delayed operation in acute appendicitis, has injured the reputation of a useful plan of therapy by advocating its application beyond its limitations.

LOCALIZED ABSCESES

In the localized abscess group there is no need for urgency; most patients respond better if treated for a day or two by the delayed method. When the abscess is palpable and the mass is lateral, the extraperitoneal approach is ideal, the incision being carried to the outer side of the mass, the aponeurosis of the external oblique being divided and the internal oblique and the transversalis being cut across in the line of the incision. The transversalis fascia and preperitoneal fat, which frequently are infected, are separated from the peritoneum. The peritoneum is then opened and, if the abscess is well to the outer side, one opens directly into the abscess without encroaching upon the free peritoneal cavity. The appendix should not be removed unless it is accessible and appendectomy can be accomplished without danger of contaminating the uninvolved peritoneal cavity. When the mass is not lateral or when for one reason or another it is not feasible to use the extraperitoneal approach, the incision should be made over the presenting mass. When arranging the drainage it is a help to place a cofferdam or Penrose drains in the appendiceal bed in such a manner as to keep the terminal ileum from contacting this area. This we believe will help to prevent post-operative obstruction.

POSTOPERATIVE TREATMENT AND FLUID THERAPY

The vitality of cells depends largely upon the integrity of their surrounding medium. The preservation or restoration of normal cellular environment is the sole purpose of fluid administration and represents the basic principle of fluid therapy.

The fluids we are interested in are the extracellular fluids, namely the blood plasma and the interstitial fluid. The latter, which con-

stitutes about 20 to 27 per cent of adult body weight, is the great reservoir of the body which bathes all tissue cells. Across it food is brought to the cells and wastes are carried away. Interstitial fluid and blood plasma may be regarded as media composed of three interdependent units: water, sodium, and chloride. Sodium and chloride are known as the major extracellular ions. When waste changes affect the extracellular fluids, sodium and chloride ions are simultaneously retained or lost, but not necessarily in equal amounts.

At present, clinical tests frequently used are the plasma chloride concentration and the carbon dioxide combining power of the plasma. They measure the concentration of chloride and alkali reserve in plasma, and reflect the concentration of these substances in interstitial fluid.

The safety mechanisms of the body which insure stability of cellular fluid environment depend largely upon kidney function. The kidneys excrete excess water with dissolved waste products. When the fluid intake is low, the kidneys excrete a smaller more concentrated quantity of urine. The interstitial fluid reservoir can shrink or expand in accordance with body needs. The hydrogen-ion concentration of the extracellular fluids is stabilized because they are buffered solutions, and their osmotic pressure remains practically constant due to the interdependence of solvents and solute.

However, there are limits beyond which the stabilizing mechanisms cannot go, and in children with appendicitis, especially the late perforation cases, those limits have frequently been passed. One of the first symptoms of a sick child is its refusal to take solid food. Soon liquids too are refused. The small fluid volume intake results in dehydration. The small caloric intake makes the child dependent upon its own tissue stores of glycogen (body carbohydrate), fat, and protein for maintenance of metabolism. Children, because of their higher metabolic rates, exert a greater demand on such stores than adults, and consequently the complications of depletion occur earlier in childhood. Fats are dependent upon carbohydrates for complete oxidation. In periods of starvation, glycogen is depleted before fat, and the fat must then be oxidized alone. Such

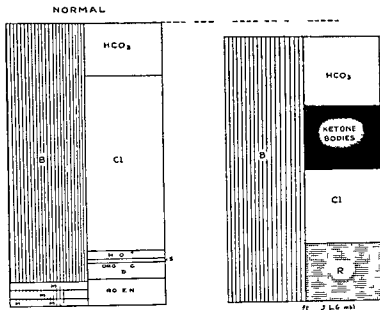


Chart 2 The double column on the left represents plasma concentration of base and acid ions in a normal individual. The second double column represents the case of a child who was vomiting because of upper intestinal obstruction. The situation is qualitatively analogous to the sequence of events in severe acute appendicitis. (Case 2 of this section.)

oxidation is incomplete leaving the so called ketone bodies (acetone, diacetic acid, and beta hydroxy butyric acid) as useless end products which cannot be oxidized alone and must be excreted in the urine. Worse still ketone bodies can be excreted only in the presence of base. This leads to acidosis of starvation.

Transposing the processes into a clinical picture, we see a child who has been too ill to eat or drink for 12 or more hours. The skin and tongue reflect dehydration. The urine contains acetone. When the blood count is taken, the hemoglobin and red cells are increased again indicating dehydration which is further corroborated by decreased urinary volume of high specific gravity. At this stage an infusion of normal salt solution with glucose will re-establish equilibrium. Glucose must be given in order to oxidize fat and ketone bodies, thus clearing the urine of acetone. Part of the salt solution replenishes the depleted body fluid reservoir. The kidneys conserve base by retaining the sodium component until the base which was lost in the excretion of ketones is replenished.

The next step in the breakdown of body balances comes with the symptom of vomiting. Since vomitus contains so much gastric juice, chlorides as well as fluid are lost to the body. Ketosis and acidosis of starvation are present. Continued vomiting brings about great chloride depletion. The continued loss of chlorides changes the picture from acidosis dehydration and ketosis to *alkalosis*, dehydration and ketosis. Gamble calls this condition *alkalosis and ketosis*. It is also called *hypochloremia*. Clinically the outstanding consideration is the presence of acetone in the urine of a dehydrated patient who is not diabetic, not in acidosis, but really in alkalosis.

Chart 2 will make these relationships clear. It is taken from Gamble and illustrates the changes discussed.

We wish to state that in this discussion we are not necessarily charting a type case of appendicitis. Rather the symptoms are taken up in an order which facilitates explanation of fluid-electrolyte changes.

Once the underlying physiology is understood, estimation of the type and quantity of

fluids to be given may be discussed. In balancing the daily intake and output, fluid losses as perspiration, hemorrhage, vomitus, and drainage must be replaced by salt solution. Blood loss is obviously best replaced by blood. Fluid loss in the urine and by vaporization (exhaled air and insensible perspiration) should be replaced by distilled water. The work of Collier and Maddock in fluid balance well illustrates this. They estimate the average fluid loss by vaporization in an adult as 2,000 cubic centimeters per 24 hours. They believe an adult should excrete from 1,000 to 1,500 cubic centimeters of urine per day, preferably the latter amount, and never less than 600 cubic centimeters. The minimum daily intake for an adult is therefore 3,500 cubic centimeters and to it they add additional quantities to cover amounts lost by vomiting, drainage, hemorrhage, etc. In children the problem is more difficult. A child's surface area is larger in proportion to its weight than an adult's and for this reason children lose proportionately more fluid by vaporization. Twenty-four hour urine specimens are difficult and often impossible to collect from children. The drawing of blood for blood chemistry determinations cannot be done frequently in infants. Moreover, a child can easily be overwhelmed—drowned—by well meant but too zealous administration of parenteral fluids.

A calculation of fluid requirements for each case must first be made. In older children this must be deduced from adult requirements. In infants, formula techniques can sometimes be used. The situation is admittedly unsatisfactory and it will remain so until values for children can be established. Careful clinical observations combined with simple laboratory tests frequently repeated must check the use of fluids throughout their administration. Optimally, the tongue should be moist and skin turgor should be preserved. The optimum urine specific gravity is in the neighborhood of 1.015; acetone and sugar should not appear. A suppression of urine frequently indicates chloride edema. In such a situation glucose and distilled water are needed to preserve kidney flow. Salt solution is not diuretic and tends to be retained if excess water is not given to facilitate the selective excretion of super-

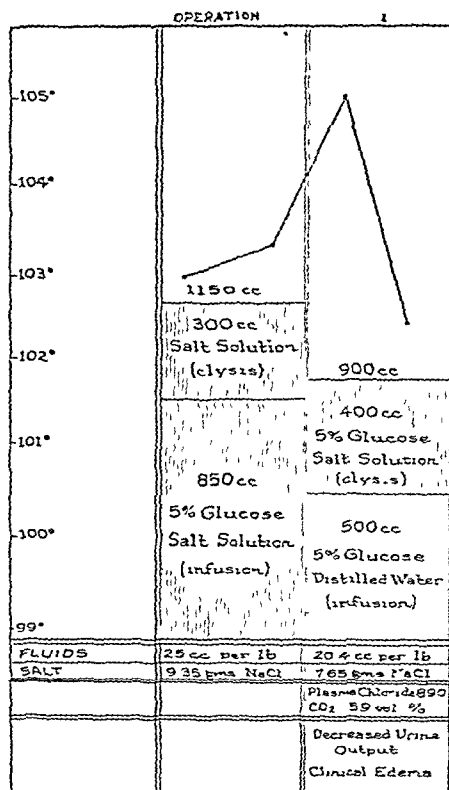


Chart 3. Case illustrating rapid development of chloride edema. This chart represents successive days in the hospital. The amounts and types of fluid are indicated. A temperature chart is superimposed.

fluorous ions. Blood chemistry determinations in children must be regarded as occasionally used procedures, very valuable, but hardly feasible as a daily routine.

Case illustrations will make these points clearer. Chart 3 illustrates the case of a well nourished 5½ year old girl who weighed 44 pounds.

She had been ill 11 hours, but had not vomited. Clinically there were no signs of dehydration. The urine specific gravity was 1.026, but no acetone was present. A diagnosis of acute appendicitis with perforation was made, and at operation a gangrenous perforated appendix was removed. The chart shows the amount and type of fluids given. On the second day edema and suppression of urine occurred. Blood chemistry determinations revealed a blood chloride of 890 milligrams per 100 cubic centimeters and a carbon dioxide combining power of 59 volumes per cent. Obviously the edema was caused by the administration of too much salt solution. When the infusion fluid was changed to 5 per cent glucose in

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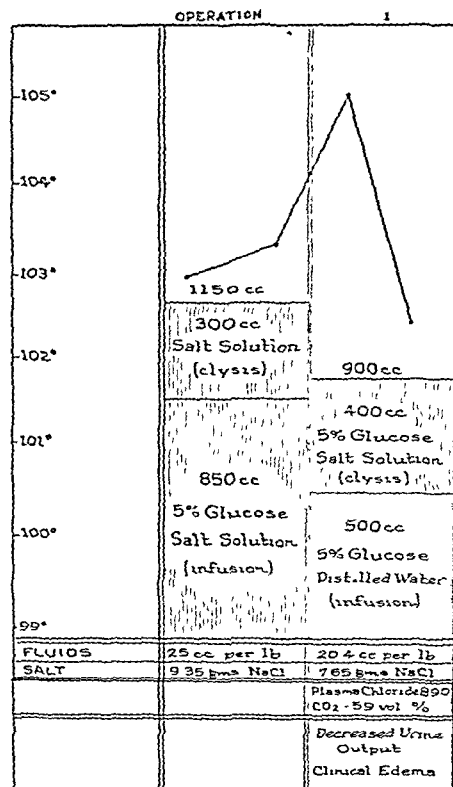


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TABLE II — ESTIMATED REQUIREMENTS

Age	20 months	weight	24 pounds	height	28 inches
Fluids	600 cc	per lb	per 24 hrs	— 1 400 cc	per 24 hrs
Energy	25 calories	per lb	per 24 hrs	— 600 calories	per 24 hrs
Salt	Probable average minimum 0.4-0.6 gm per day				
	Average intake 1.5-2.5 gm per day				
	Maximum amount tolerated greatly above average intake				
	Determined by excretory ability of kidneys				

distilled water urine output was re established and edema disappeared. The 5 per cent glucose in water solution is practically isotonic and is the proper solution for use when water is needed and electrolytes are not depleted.

This case illustrates the effect of overzealous administration of salt solution to a child who, though slightly dehydrated, was not in electrolytic imbalance.

Another instructive case is that of a child 20 months old.

A 36 hour history revealed principally listlessness, refusal of food, purgation, vomiting and abdominal swelling. The salient point on physical examination was a huge symmetrically distended tender and rigid abdomen. The tongue was dry, the skin was wrinkled. Pulse respirations and temperature were all elevated. The specific gravity of the urine was 1.019 and acetone was present. Clearly this was a typical case of dehydration, letosis and hypochloremia. A hemoglobin of 40 indicated marked anemia. The intra abdominal complaint was first diagnosed as intestinal obstruction and operation was decided upon with the intention of exposing the cecum, possibly doing a cecostomy, and at any event examining the appendix. At operation under local anesthesia through a McBurney incision a perforated appendix with peritonitis and paralytic ileus was found. The appendix was removed and drainage instituted. The drainage consisted of a rubber tube in the pelvis, a cigarette drain at the appendiceal site and a cigarette drain in the lateral paracolic groove. The problem of postoperative treatment then arose. The requirements of the child who weighed 24 pounds were calculated on a formula basis and are expressed in Table II.

The progress of the case is shown in Chart 4. The first column represents fluids given on the day of operation as well as on the first postoperative day. The urine analyses are instructive, acetone vanished indicating that the administered glucose was effective, no sugar appeared showing that administered glucose was being utilized, the reaction changed from acid to alkaline, probably indicating that base had been replenished within the body and the kidneys were excreting the administered sodium but retaining chloride. On the third postoperative day sugar appeared in the urine and therefore the glucose

content of the infusion solution was changed from 10 per cent to 5 per cent. Thereafter the urine was sugar free. Slight puffiness of the face and decreased urine output occurred toward the end of the fourth day. Therefore the infusion solution was changed to 5 per cent glucose in water. Puffiness did not progress and the extremely low urine specific gravity of 1.002 indicated that the volume of body fluids had been more than restored. On this day too water was first given by mouth and tolerated. Parenteral fluids were therefore discontinued. Undoubtedly chloride edema was imminent on the fourth day, but this could not be determined chemically because the child's only available vein carried the infusion cannula.

The case serves as an illustration of the amount of water and salt a depleted organism may require. It also illustrates how simple observations can reveal internal changes and how therapy can, if necessary, be guided in the absence of complete laboratory data.

The edema which occurred in the first patient and was incipient in the second is the so called chloride edema. The mechanism seems to be a piling up of water, chloride and sodium (pre renal deviation) in the interstitial tissues when superfluous amounts of salt solution are administered parenterally. If plasma proteins are depleted by blood loss, wound drainage, or previous undernutrition, chloride edema will occur more readily. Profuse drainage undoubtedly plays an important rôle in depleting plasma proteins in these cases.

Patients with peritonitis are routinely given a small transfusion every other day until parenteral fluids are discontinued. In the second case 80 to 100 cubic centimeters were given each time. In larger children 150 to 300 cubic centimeters are given. The value of transfusions lies, we believe, in the support they give to the blood proteins and the immune bodies as well as to the red cells.

Distention as a complication in the post operative course deserves special mention. Not only does a distended abdomen splint the diaphragms and increase the risk of pulmonary complications, but Herrin and Meek have conclusively shown that when the bowel is distended, fluid is actually secreted into the lumen. Such fluid is lost to the body until relief of distention permits reabsorption. Heat applied intermittently to the abdomen, glycerine and water enemas and the rectal tube are

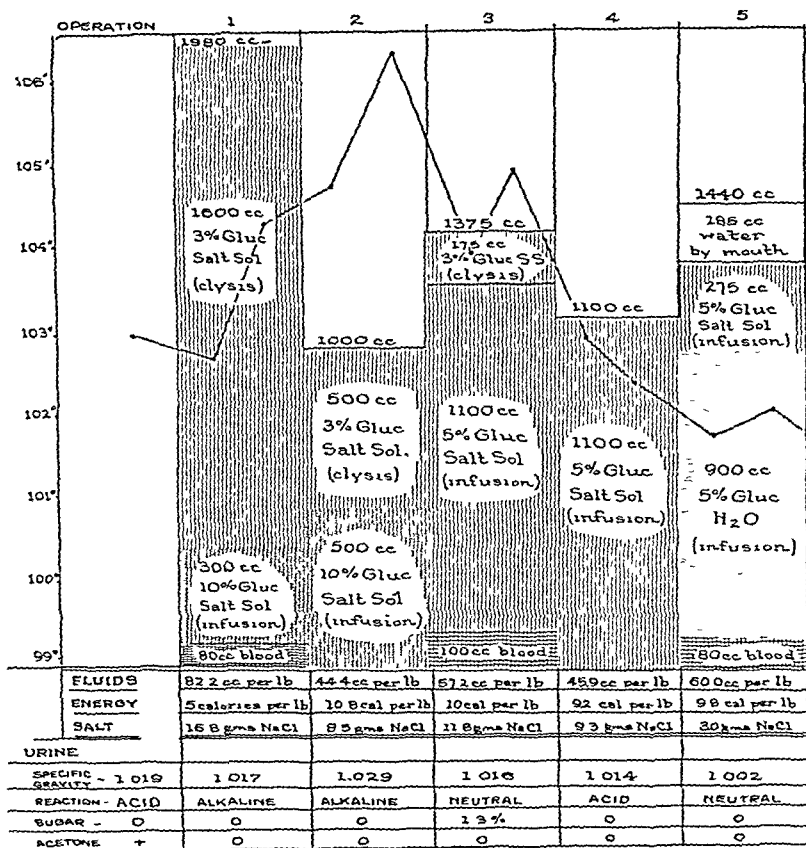


Chart 4 This chart represents successive days in the hospital. The amounts and types of fluid are indicated. A temperature chart is superimposed.

sometimes sufficient to control distention. When they are not adequate, the Wangensteen suction apparatus and repeated small doses of pitressin practically always bring relief. We believe that the relief of distention far outweighs the possibility of spreading a peritonitis by stimulation of bowel contractions.

In the suppurative and peritonitis cases the presence of nausea, vomiting, and distention calls for the use of gastric lavage, preferably by means of the Wangensteen suction apparatus. In the peritonitis cases this procedure is used routinely, both before and after operation. Fluid requirements are estimated. When the daily intake and output are balanced, fluid losses by perspiration, vomitus, Wangensteen drainage, and other drainage must be replaced by salt solution. Blood loss is obviously best replaced by blood. Fluid loss in

urine and by vaporization should be replaced by distilled water. Fluids are given subcutaneously or intravenously. Normal salt solution is used subcutaneously. Intravenously, 5 per cent glucose in normal salt solution is alternated with 5 per cent glucose in distilled water as calculations indicate. Half normal saline solution with $2\frac{1}{2}$ per cent glucose may be used.

The preservation or restoration of normal cellular environment is the sole purpose of fluid administration. Critical clinical observation with frequent blood counts and daily urinalyses must sometimes serve as the only guides. When determinations of plasma chloride concentration and carbon dioxide combining power, together with blood urea and blood sugar values can be obtained, additional information is secured.

TABLE III — POSTOPERATIVE COMPLICATIONS

Complication	Cases
Intestinal obstruction	4
Fecal fistula	1
Transient fecal fistula	3
Secondary abscess	2
Wound infection	6
Pneumonia	3
Bronchitis	2
Otitis media bilateral	1
Acute tonsillitis	1
Abscess of thigh following hypodermoclysis	1

POSTOPERATIVE COMPLICATIONS

The postoperative complications in this series are shown in Table III. They are the conditions which increased morbidity and, in some cases, threatened to increase mortality. Concurrent illnesses present on admission, such as diabetes or pyelitis, are not listed. Complications which caused death are discussed in the section on mortality. Those listed here resulted in complete recovery.

Intestinal obstruction was by far the most serious postoperative complication. It occurred in 4 cases. All were of the perforated group

CASE 1. Patient developed intestinal obstruction on the twentieth day. Obstruction was found at the terminal ileum. Ileocolostomy and an ileostomy above the anastomosis were performed. The child left the hospital 26 days after the second operation.

CASE 2. Patient developed obstruction on the twenty-ninth day. Obstruction was found at the terminal ileum, adhesions were divided and the obstruction was relieved. The child was discharged 23 days after the second operation.

CASE 3. Patient developed obstruction on the nineteenth day, failed to respond to conservative treatment and was operated upon the twentieth day. A loop of ileum was bound down in the pelvis, kinked and obstructed. The loop was freed thus relieving obstruction but due to torn serosa and exudate in this part of the ileum an ileo-ileostomy was performed. Patient was discharged 20 days later.

CASE 4. Patient developed obstruction on the nineteenth postoperative day. The obstruction was found due to the matting together of loops of small intestine about an abscess. The abscess was drained. Ileostomy was performed above the involved ileum. Patient was discharged 27 days after the second operation.

It is of interest to note that the primary operation in these 4 cases was performed through a McBurney incision. This, we feel, made the secondary operations less complicated by using a right rectus incision the obstruction was

approached through an uncontaminated field free of adhesions.

Fecal fistula. Four patients developed fecal fistulas. All of these at primary operation had a ruptured appendix and required drainage.

CASE 1. Fecal drainage started on the third day after operation and ceased on the eleventh day. The entire stay in the hospital was 24 days.

CASE 2. At the primary operation the appendiceal junction was gangrenous. A fecal fistula developed 16 days after operation following the removal of drainage. Free drainage ceased in 14 days. Intermittent drainage continued for 2 more weeks. The entire stay in the hospital was 59 days.

CASE 3. A fecal fistula developed 12 days after operation and drained for 8 days. The child was in the hospital 32 days.

CASE 4. This is the only case in the fecal fistula group which did not heal spontaneously. At primary operation the appendix was not removed. Abscesses under the liver in the pelvis and at the ileocecal junction were drained. A fistula appeared on the eighth day. The child had a very stormy convalescence. The fecal fistula failed to heal spontaneously. A second operation several months later revealed multiple fistulas to the cecum and terminal ileum necessitating a resection of the cecum and terminal ileum followed by an ileocolostomy.

Secondary abscesses. In two cases secondary abscesses developed.

CASE 1. At the primary operation a perforated appendix was removed. One cigarette drain was placed down to the appendiceal site and one rubber tube in the pelvis. The child pulled out the drains on the sixth day. A secondary pelvic abscess formed which necessitated operation and drainage on the fifteenth day.

CASE 2. At primary operation a gangrenous appendix covered with exudate was removed. The wound was closed without drainage. Patient had a stormy postoperative period. Finally on the thirty-fourth day after operation a huge pelvic abscess was drained by the abdominal route. The abscess extended from the pelvis up the left paracolic groove.

Wound infection. Six cases occurred. One of the 6 was a drained case in which the spread of infection necessitated the laying open of the entire wound. No other drained cases are included. Of the 5 remaining wound infections, 2 occurred after secondary operations for intestinal obstruction. Only one McBurney incision became infected.

Pneumonia. The 3 cases were all the bronchial type. One occurred on the twenty-third day following an acute tonsillitis which first

TABLE IV.—DIVISION OF CASES IN THREE GROUPS

	Number	Percentage	Deaths	Mortality %
1 Non-perforated cases	146	62.2	0	0
2 Perforated with localized abscess	14	5.9	1	7.1
3 Perforated with peritonitis	75	31.9	9	12.0
Total	235	100.0	10	4.26

TABLE V.—CHILDREN 5 YEARS OF AGE AND UNDER

	Number	Percentage	Deaths	Mortality %
Non-perforated cases	10	30.3	0	0
Perforated with peritonitis	23	69.7	5	21.7
Perforated with localized abscess	0	0	0	0
Total	33	100.0	5	15.15

appeared on the eighteenth day. The second case was further complicated by bilateral otitis media. The patient, who was 18 months of age, and whose appendix was perforated, had a head cold when he was admitted to the hospital.

A single case of abscess following hyperdermoclysis casts no reflection on a procedure which is very valuable in children.

MORTALITY

Of the 235 cases in this series 10 patients died, setting the mortality at 4.26 per cent. Eighty-nine, or 31.0 per cent of the cases, were perforated and all the deaths occurred in this group, thus giving a mortality of 11.2 per cent for all the ruptured cases. Fourteen of the latter were cases of localized abscess. One of these patients died, making the mortality for the localized abscess group 7.1 per cent. The perforated cases are not divided into subgroups of local or spreading peritonitis. It is often difficult to tell the extent of peritonitis at the operating table, this is especially true when the McBurney incision, the incision of choice at this clinic, is used. Moreover, different operators will not agree on the extent of a peritonitis. Bancroft, in a recent article, is also of this opinion. We divide our cases into 3 groups: non-perforated, perforated with localized abscess, and perforated with peritonitis (Table IV).

TABLE VI.—COMPARISON OF MORTALITY OF OTHER CLINICS

Author	Number of Cases	Perforated %	Mortality %
Maes et al *	250	—	7.6
Stone†	258	45	7.75
McLanahan‡	179	—	3.91
Woodall*	295	—	7.45
This series†	235	37.8	4.26

*All 12 years and under.

†All 14 years and under

‡All 13 years and under

TABLE VII.—COMPARISON OF MORTALITY RATES WITH OTHER CLINICS IN CHILDREN 5 YEARS OF AGE AND UNDER

Author	Number of cases	Perforated %	Mortality %
Maes et al *	22 or 23	77.3	22.7
Leonard and Derow	23	74	8
McLanahan	27	—	22.2
Heyl	90	—	12.2
This series	33	69.6	15.15

*These cases are 9 per cent of 250

Thirty-three of the cases were 5 years of age or younger. This group is 13.6 per cent of the entire series (Table V). The general mortality of the group is 15.15 per cent. Twenty-three, or 69.6 per cent, were perforated and 5 of these cases died, a mortality of 21.7 per cent for ruptured cases in the younger age group. No cases of localized abscess occurred in this group.

These figures are compared with mortality rates from other clinics (Tables VI and VII).

A summary of the histories of the 10 patients who died follows and our decision as to the cause of death is noted for each (Table VIII):

CASE 1. P. S., aged 11 years. Patient had been sick 3 days and had been purged. Child was operated on 8 hours after admission, following an infusion of saline and glucose. The appendix was perforated, peritonitis was present. Operation consisted merely of drainage, the appendix not removed. The child died 48 hours after operation, cause of death, peritonitis.

CASE 2. R. H., aged 8 years. Child came to the hospital and a diagnosis of subacute appendicitis, bronchitis, and pharyngitis was made. She was operated on 10 days after admission. A diagnosis of chronic or subsiding appendicitis was then made.

TABLE III—CAUSES OF DEATH

	Number
Peritonitis	5
Secondary abscess followed by peritonitis	1
Intestinal obstruction	2
Intestinal obstruction and peritonitis	1
Pneumonia	1

At operation a retrocecal appendix was found with localized abscess at the tip. The appendix was removed and drainage was instituted. Child died of peritonitis 14 days after operation. A fecal fistula having developed.

CASE 3 J W aged 5 years. Patient had been ill 48 hours. Entered hospital with temperature of 104 degrees, pulse, 130 respirations, 40. Child was operated on immediately, and a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. The child died 2 days following operation of peritonitis, due to the streptococcus.

CASE 4 L D aged 2 years. Child had been ill 6 days with persistent vomiting. Was in hospital 10 hours before operation. Before operation patient was given an infusion. At operation a perforated appendix with peritonitis was found. Appendectomy and drainage. Child died 60 hours after operation cause of death peritonitis.

CASE 5 J K, aged 2½ years had been ill 48 hours. At operation a ruptured appendix with peritonitis was found. There was also a pedunculated Meckel's diverticulum which was evidently not involved. The child died 24 hours after operation, from peritonitis. Cultures showed the colon bacillus.

CASE 6 L W aged 4 years had been ill 4 days. Persistent vomiting had been present for 24 hours before admission. At operation a ruptured appendix was found with peritonitis. A link in the terminal ileum produced complete obstruction. Operation consisted of appendectomy and drainage and the freeing of obstruction. Child died 1 hour after operation. The cause of death was intestinal obstruction and peritonitis.

CASE 7 W K aged 7 years. At primary operation a ruptured appendix with peritonitis was found. Appendectomy with drainage was done. Convalescence was normal for 10 days then intestinal obstruction developed. A second operation was done revealing obstruction in the terminal ileum due to adhesions to the abdominal wall. The terminal ileum was beefy and dark in color. Ileocolostomy was performed. Patient died 24 hours following last operation—cause of death intestinal obstruction.

CASE 8 A C aged 7 years. Child had been ill 48 hours. At operation a perforated appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal for 7 days then child developed symptoms of intestinal obstruction. Patient was carried along for another 24 hours, and was then operated again. The terminal ileum was obstructed due to adhesions at the appendiceal site. The adhesions were separated and the obstruction was released. The child died 4 days

following this operation—cause of death intestinal obstruction.

CASE 9 M B aged 3 years. Child had been ill 4 days before operation. At operation a ruptured appendix with peritonitis was found. Child had a normal convalescence for 16 days after operation then developed temperature and cough and then bronchial pneumonia. The chest was tapped and thin pus was obtained. Culture of which showed the streptococcus. The cause of death was bronchopneumonia complicated by empyema.

CASE 10 J M aged 4 years had been ill 2 days. At operation a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal until the fourteenth day, when child developed fever and distention. Three days later the child was again operated upon. A localized collection of pus was found in the pelvis. There was pelvic peritonitis but no obstruction. The pelvic abscess was drained. Child died 7 days following last operation—cause of death, peritonitis.

In the first 5 cases we believe that the primary cause of death was peritonitis. Case 1 is the only one in the series in which the appendix was not removed in the presence of peritonitis. In Case 2 there was an appendiceal abscess and the appendix was removed with difficulty, which we feel was an error in operative judgment, for following the operation the child developed a typical peritonitis. In Case 5 a Meckel's diverticulum, which was not diseased, was removed. Such procedures we feel are not wise in the presence of an acute appendiceal infection.

In Case 6 there was a linked terminal ileum with obstruction in addition to the appendiceal lesion. The child's preoperative condition was critical and operation was finally decided upon with hesitancy. The child died 1 hour after operation. In this case nothing could have been lost by delaying operation decompressing the intestinal tract, and administering fluids.

In Cases 7 and 8 deaths are clearly due to postoperative intestinal obstruction. The cases were operated upon a second time on the seventh and tenth days respectively, and the obstruction was found at the terminal ileum. In Case 7 an ileocolostomy was performed. In Case 8 the adhesions were simply freed.

In Case 9 convalescence was normal for 16 days when a bronchopneumonia developed. We feel warranted in listing this as a pulmonary death.

In Case 10 a secondary pelvic abscess developed requiring a second operation and drainage. The child died of a pelvic peritonitis.

In reviewing the operative technique in these 10 fatal cases, the authors feel it is very significant that the McBurney incision was employed in only one of the cases, the right rectus being used in the others.

SUMMARY AND CONCLUSIONS

A series of 235 cases of acute appendicitis in children is presented. The series is studied from the viewpoint of what can be done for a child with acute appendicitis when patient enters a hospital. The details of pre-operative preparation, operative procedure, and post-operative care are discussed. The use of parenteral fluids is stressed as the most important part of postoperative care.

Although acute appendicitis is a common disease and its treatment is standardized to some extent, the mortality from this illness is still too high. The mortality of appendicitis is particularly high at the extremes of life.

The series of cases presented covers 7 years. The general mortality is 4.26 per cent and the mortality for children 5 years of age and younger is 15.15 per cent. The first 3 and the last 4 years of the study show clear-cut differences in operative procedures, postoperative treatment, and mortality. In the second of these two periods the mortality of acute appendicitis with perforation and peritonitis was strikingly lowered. In the entire series it fell from 16.3 per cent to 6.5 per cent. In the children under 6 years of age it fell from 33.3 per cent to 17.6 per cent.

A decrease in the use of the right rectus incision and an increase in the use of the McBurney incision paralleled the fall in mortality.

During the first 3 years of the study, fluid administration was poorly understood; but in the last 4 years, with increasing knowledge of underlying physiology, the use of parenteral fluids and their importance as an integral part of postoperative treatment was definitely established.

We believe that by continued emphasis of three cardinal points, namely, careful pre-

operative preparation, individualized operative technique, and skillful postoperative care, a further reduction in the mortality of acute appendicitis in children can be attained.

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TABLE VIII—CAUSES OF DEATH

	Number
Penttonitis	5
Secondary abscess followed by penttonitis	1
Intestinal obstruction	2
Intestinal obstruction and penttonitis	1
Pneumonia	1

At operation a retrocecal appendix was found with localized abscess at the tip. The appendix was removed and drainage was instituted. Child died of peritonitis 14 days after operation. A fecal fistula having developed.

CASE 3 J W aged 5 years. Patient had been ill 48 hours entered hospital with temperature of 104 degrees, pulse, 130 respirations 40. Child was operated on immediately and a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. The child died 2 days following operation of peritonitis due to the streptococcus.

CASE 4 L D aged 2 years. Child had been ill 6 days with persistent vomiting. Was in hospital 10 hours before operation. Before operation patient was given an infusion. At operation a perforated appendix with peritonitis was found. Appendectomy and drainage. Child died 60 hours after operation cause of death peritonitis.

CASE 5 J H, aged 255 years had been ill 48 hours. At operation a ruptured appendix with peritonitis was found. There was also a pedunculated Meckel's diverticulum which was evidently not involved. The child died 24 hours after operation, from peritonitis. Cultures showed the colon bacillus.

CASE 6 L W aged 4 years had been ill 4 days. Persistent vomiting had been present for 24 hours before admission. At operation a ruptured appendix was found with peritonitis. A kink in the terminal ileum produced complete obstruction. Operation consisted of appendectomy and drainage and the freeing of obstruction. Child died 1 hour after operation. The cause of death was intestinal obstruction and peritonitis.

CASE 7 W K aged 7 years. At primary operation a ruptured appendix with peritonitis was found. Appendectomy with drainage was done. Convalescence was normal for 10 days then intestinal obstruction developed. A second operation was done revealing obstruction in the terminal ileum due to adhesions to the abdominal wall. The terminal ileum was beefy and dark in color. Ileocolostomy was performed. Patient died 24 hours following last operation—cause of death intestinal obstruction.

CASE 8 A C aged 7 years. Child had been ill 48 hours. At operation a perforated appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal for 7 days then child developed symptoms of intestinal obstruction. Patient was carried along for another 14 hours and was then operated again. The terminal ileum was obstructed due to adhesions at the appendiceal site. The adhesions were separated and the obstruction was released. The child died 4 days

following the operation—cause of death intestinal obstruction.

CASE 9 M B aged 3 years. Child had been ill 4 days before operation. At operation a ruptured appendix with peritonitis was found. Child had a normal convalescence for 16 days after operation then developed temperature and cough, and then bronchial pneumonia. The chest was tapped and thin pus was obtained culture of which showed the streptococcus. The cause of death was bronchopneumonia complicated by empyema.

CASE 10 J M, aged 4 years had been ill 2 days. At operation, a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal until the fourteenth day, when child developed fever and distention. Three days later the child was again operated upon. A localized collection of pus was found in the pelvis. There was pelvic peritonitis but no obstruction. The pelvic abscess was drained. Child died 2 days following last operation—cause of death peritonitis.

In the first 5 cases we believe that the primary cause of death was peritonitis. Case 1 is the only one in the series in which the appendix was not removed in the presence of peritonitis. In Case 2 there was an appendiceal abscess and the appendix was removed with difficulty, which we feel was an error in operative judgment for following the operation the child developed a typical peritonitis. In Case 5 a Meckel's diverticulum, which was not diseased, was removed. Such procedures we feel are not wise in the presence of an acute appendiceal infection.

In Case 6 there was a kinked terminal ileum with obstruction in addition to the appendiceal lesion. The child's pre-operative condition was critical and operation was finally decided upon with hesitancy. The child died 1 hour after operation. In this case nothing could have been lost by delaying operation decompressing the intestinal tract, and administering fluids.

In Cases 7 and 8 deaths are clearly due to postoperative intestinal obstruction. The cases were operated upon a second time on the seventh and tenth days respectively, and the obstruction was found at the terminal ileum. In Case 7 an ileocolostomy was performed, in Case 8 the adhesions were simply freed.

In Case 9 convalescence was normal for 16 days when a bronchopneumonia developed. We feel warranted in listing this as a pulmonary death.

INTRAVENOUS CALCIUM CHLORIDE AND ITS USE FOR THE RELIEF OF VISCERAL COLIC

A Clinical and Experimental Study

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SINCE Aub and his associates first observed that calcium chloride given by vein to patients with lead colic produced immediate relief, little has been done to emphasize the importance of this drug as an agent for the relief of spasmodic visceral pain. A search of the literature reveals that its use as an analgesic has been limited. Bauer, Salter, and Aub reported favorable results from its administration in various colics. The cramps of bile duct and ureteral obstruction and those of tuberculous enteritis and lead colic have been readily relieved by its use. The pain in these cases was thought to result from smooth muscle spasm, and the relief was attributed to smooth muscle relaxation. Calcium chloride, therefore, was credited with the property of relaxing smooth muscle. With these facts in mind it seemed worth while to investigate further its usefulness in the relief of colic-like pain and in bladder spasm. This report is a presentation of clinical observations on the effects of intravenous calcium chloride and of experimental studies dealing with its mode of action.

PROCEDURE

The clinical value of intravenous calcium chloride was tested by administering the drug to patients suffering from severe visceral pain on the surgical and urological services of the Massachusetts General Hospital. Each patient received one or more 10 cubic centimeter doses of a sterile aqueous solution of 10 per cent calcium chloride at a rate of 1.5 to 2 cubic centimeters per minute. Since calcium chloride is irritating in extravascular tissues, care was taken to avoid subcutaneous injection. The drug produced, in all cases, a warm sensation in the mouth and often over the entire

body. The intensity of this reaction was used as a guide to the rate of injection. Occasionally, if given too rapidly, nausea was experienced and rarely vomiting followed. There was no demonstrable effect upon the heart rate. The drug is contra-indicated in patients receiving digitalis. Calcium chloride in large doses in animals produces bradycardia and finally cessation of the heart beat in systole (6, 8). This action apparently is intensified in digitalized subjects. Two fatalities have recently been reported following the intravenous administration of calcium salts in patients who were receiving digitalis (4).

Calcium chloride was given to 16 patients suffering from various kinds of spasmodic pain. Nine were completely relieved, 3 partially relieved, and 4 were not benefited. The 16 patients may be classified in 4 groups, according to the type of colic: (1) 8 patients suffering from renal colic; (2) 5 patients suffering from severe bladder spasm secondary to urethral or trigone irritation; (3) 2 patients suffering from excruciating gall-stone colic; (4) 1 patient complaining of postoperative gas pains.

EXPERIMENTAL OBSERVATIONS

In order to obtain information on the mode of action of calcium chloride, cystometric studies were made in 9 patients. Six of these had abnormal bladders from prostatic obstruction, and 3 had normal bladders. The human urinary bladder was chosen for study because it is easily adaptable to cystometry; because it is composed chiefly of smooth muscle controlled by the autonomic nervous system; and because an important part of the clinical material presented bladder symptoms. A simple water manometer connected to a fluid reservoir served as a very accurate cystometer. A standard rubber urethral catheter was used to connect the apparatus with the

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derived. The experimental findings are illustrated by Figures 1 and 2. The observations fall in groups as follows

Group 1. Renal colic. Five of the 8 patients with renal colic were relieved of their pain for 10 to 45 minutes; 2 were relieved for 12 hours or more, and 1 received no benefit. This last case was unusual in that the pain was secondary to the congenital anomaly of double pelvis and ureter. No evidence of obstruction or inflammation was found in this patient at the time of operation.

Group 2. Bladder spasm. After intravenous calcium chloride, 3 of the 5 patients suffering from severe bladder spasm were relieved of pain for 5 to 18 hours. Repetition of the drug in each favorable case was followed by a similar beneficial effect. Two patients received no benefit. Both of these were suffering from spasm secondary to such extensive disease that relief was obtained only by repeated large doses of morphine.

Group 3. Gall-bladder colic. Two patients suffering from severe gall-stone colic were completely relieved for $\frac{1}{2}$ and 10 hours, respectively, after the administration of calcium chloride. Both patients were operated upon and each was found to have common duct stones.

Group 4. Postoperative gas pains. One patient suffering from gas pains 4 days after appendectomy was given the drug without relief.

Group 5. Cystometric observations. The cystometrograms of normal and pathological bladders have been discussed in another paper (9). After the administration of calcium chloride, in no case was there any change in the

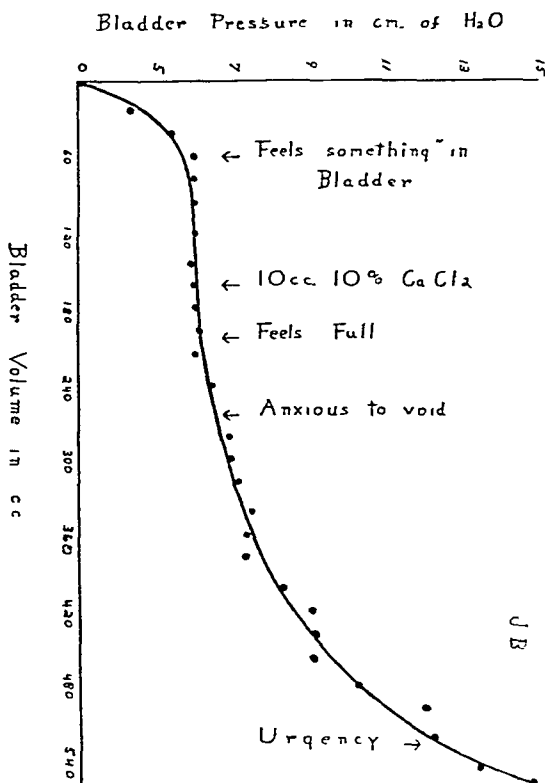


Fig 1 Normal cystometrogram of a 50 year old man. Ten cubic centimeters of 10 per cent calcium chloride were given intravenously as indicated, with no effect upon the shape of the curve.

shape of the cystometrogram or in the tone of the bladder. The sensations of urgency experienced as the bladder became distended were not relieved, nor were the marked rhythmic contractions observed at this point altered by the drug (Figs 1 and 2).

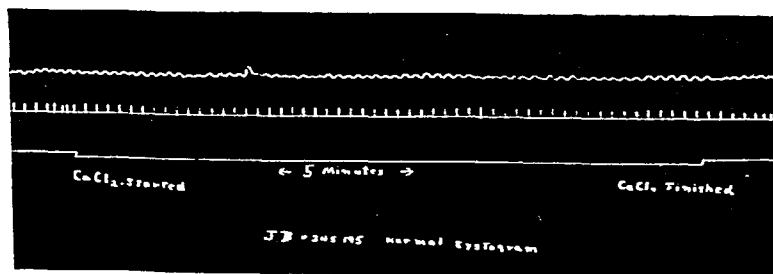


Fig 2 A kymographic record of the same experiment showing that there is no change upon the bladder tone.

TABLE I—CASES IN WHICH CALCIUM CHLORIDE WAS EFFECTIVE

Patient	Disease	Type of pain	Effect of CaCl	Remarks
F M 5 F 342-903	Left ureteral lithiasis	Renal colic	Immediate relief of pain	Patient awakened at 2 a.m. with severe renal colic in spine. Following ureteral catheter After CaCl ₂ had immediate relief of pain and slept again. Pain did not recur.
E M 18 F 343-610	Left hydro-nephrosis from obstructed vessel	Renal colic	Immediate relief of pain	Colic completely relieved until operation 2 days later but after 3 hrs patient had a return of dull ache in left C.V. which did not require medication. At operation hydronephrosis and obstructed vessel found.
M F 31 M E.W. 44 n	Ureteral lithiasis	Renal colic	Immediate relief of pain	Patient was given 1 gr of mephine with part 1 of CaCl ₂ before CaCl ₂ . Followed complete relief for 45 min. A second dose of 1 gr later was effective for 10 min. Vomiting produced each time.
W B 30 M E.W. 4 n	Polycystic kidneys	Renal colic	Immediate relief of pain	Complete relief of the colic after 12 hrs but dull left flank pain remains. Retrograde pyelogram showed bilateral polycystic kidneys.
N O 40 M E.W. 415	Right nephrolithiasis	Renal colic	Immediate relief of pain	Had been having constant severe colic until CaCl ₂ was given. Pain to some extent was produced for 10 min. The colic was relieved but a dull ache remained. Colic then returned and was partially relieved by morphine 1 gr.
F H 64 F 343-447	Right renopelvic lithiasis	Renal colic	Immediate relief of pain	Awakened with severe colic. CaCl ₂ produced relief of colic for 30 min. Dull ache remained. Right renopelvic lithiasis was demonstrated by x-ray and confirmed at operation.
G M 33 M 343-259	Left ureterolithiasis	Renal colic	Immediate relief of pain	Entered having severe renal colic from a renal pelvic stone. CaCl ₂ produced immediate relief of the colic but a dull ache remained. The colic did not recur during the 4 days after operation before operation. Retrograde pyelogram showed stone and hydronephrosis of left kidney confirmed at operation.
F S 65 M 342-344	Ruptured urethra	Bladder spasm	Immediate relief of complete	Patient on constant drainage to ruptured urethra. Developed severe bladder spasm around the catheter. Given CaCl ₂ three times in 3 days with complete relief for 12 to 18 hrs each time.
E I 23 F 342-204	Constant drainage of bladder	Bladder spasm	Immediate relief of complete	Patient on constant drainage but having severe bladder spasm. Given CaCl ₂ three times in 10 days with relief for 18 to 24 hrs each time. Had previous history of bladder spasm after 1/2 hr. Complete relief on several occasions.
A B 70 M 342-057	Benign prostatic hypertrophy	Bladder spasm	Immediate relief of complete	Perineal prostatectomy, placing catheter. Spasms at 15 min intervals relieved by CaCl ₂ 4 hrs. Second dose 15 hrs later had a similar effect.
A O 41 M 342-033	Cholelithiasis	Biliary colic	Immediate relief	Very frequent attacks relieved for 4 hrs permitting sleep after each of two doses on separate days. Common duct not removed. Peristalsis.
N R 44 F 342-044	Cholelithiasis	Biliary colic	Immediate relief	Awakened by severe colic. Given CaCl ₂ with complete relief for 10 hrs. Common duct not removed. Peristalsis.

TABLE II—CASES IN WHICH CALCIUM CHLORIDE WAS NOT EFFECTIVE

Patient	Disease	Type of pain	Effect of CaCl	Remarks
S M 8 F 342-628	Double right ureter and pelvis	Renal colic	relief	Patient had attacks typical renal colic. Pyelogram showed double right ureter and pelvis with obstruction in either. At operation there was no evidence of lithiasis or infection.
S T 64 M 342-307	Benign prostatic hypertrophy marked cystitis	Bladder spasm	No relief	May have bladder spasms around only catheter. Given two doses of CaCl ₂ without relief of either cystitis or spasm. Patient had a very severe cystitis.
C T 74 M 342-357	Constant drainage of bladder	Bladder spasm	No relief	Patient with severe bladder spasm. Suprapubic tube placed but no relief of spasm. The dose was too low and there was marked cystitis. The dose of CaCl ₂ was ineffective.
H G 10 M 343-534	Acute appendicitis postoperative	Gas pain	No relief	Patient having other marked gas pain in second postoperative day. Given CaCl ₂ with no relief.

bladder. A Brodie bellows which recorded on a smoked drum kymograph was attached to the open top of the manometer when permanent records were desired (9). Ten cubic centimeters of 10 per cent calcium chloride was given intravenously to each of these patients at different points along the cystometric curve.

RESULTS

In the group of cases in which calcium chloride was given therapeutically the results were extremely gratifying and in some cases dramatic. Table I gives a summary of each case which responded favorably to the drug and Table II lists the cases in which no benefit was

THE RELATION OF SPASM OF THE SECOND PORTION OF THE DUODENUM TO BILIARY COLIC

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PAUL A. KNEPPER, M.D., Gilman, Colorado,

WALTMAN WALTERS, M D, F.A.C.S., and ALBERT M. SNELL, M D, Rochester, Minnesota

PREVIOUS papers by three of us (2, 3, 4, 7) and Butsch were concerned with reports showing that, in certain individuals, attacks of biliary colic following cholecystectomy were associated with contraction of the sphincter of the common bile duct which temporarily prevented bile from entering the duodenum and which resulted in elevations of pressure within the biliary system. It was shown that morphine could produce this spasm, and that in cases in which patients were suffering from the syndrome of postcholecystectomy colic its administration would result in a definite and severe attack of biliary colic.

The question that presented itself to us at that time was whether or not the spasm associated with postcholecystectomy biliary pain involved only the separate sphincter of the common duct, the existence of which was recently demonstrated embryologically by Boyden, or whether the duodenal musculature was also involved. That disturbed gastrointestinal motility is in some way involved in biliary colic has been shown by the studies of Westphal who demonstrated delayed emptying of the stomach during attacks of biliary pain. The findings to be reported here are in partial accord with Westphal's observation, and they support the theory that contraction of the duodenal musculature may play a rôle in the production of certain symptoms associated with biliary colic.

METHODS OF STUDY

Both patients suffering from repeated attacks of postcholecystectomy biliary colic and a series of normal individuals were studied

From the Divisions of Surgery and of Medicine, The Mayo Clinic

In each case a Sawyer tube was passed into the stomach. The patient was directed to lie on his right side, and the stomach was repeatedly lavaged with warm water in order to free it of all mucus and secretion. The tube was then allowed to pass into the duodenum, its location was verified by a free flow of clear bile, by a characteristic tugging sensation transmitted to the piston of the syringe when the tube was aspirated, and by roentgenograms. The duodenal tube was then connected to a straight, glass tube manometer containing a float for recording changes in pressure on a smoked drum (Fig. 1). The system was filled from a reservoir bottle with warm physiologic saline solution. When the reservoir was clamped off from the rest of the system, there remained a continuous column of water extending from the duodenum to the manometer. The readings of pressure thus obtained were recorded in millimeters of water.

In a few cases a rubber balloon was tied over the lower end of the duodenal tube; this was passed into the duodenum and a small amount of water was injected into it through the duodenal tube. Care was taken not to overdistend either the rubber bag or the duodenum. The end of the closed tube was then attached to the manometer for measuring changes in pressure within the duodenum. The closed system gave results identical to those obtained when the open system was used.

On several occasions in one case, two duodenal tubes were passed simultaneously. To one was attached a rubber bag, whereas the other opened freely into the duodenum. By switching the manometer from one tube to the other, without allowing the escape of fluid and therefore not altering the volume of fluid

EVALUATION OF STUDY

The use of calcium chloride for the relief of colic like visceral pain is empirical in that no satisfactory explanation for its action has been advanced. Several interesting observations, however, can be assembled and speculations offered. It was suggested and discarded by Aub and his associates that calcium chloride produced relief by relaxing smooth muscle. Their observations on the activity of obstructed intestinal loops in dogs showed that no change was produced by intravenous calcium chloride when given in twice the human dosage (5). Rozen and Perusse were unable to demonstrate definite effects on gastric contractions in dogs by oral or intravenous administration of calcium chloride or lactate. Bigg and Rosenblueth have shown that in the cat calcium chloride does not relax smooth muscle in the nictitating membrane or the non pregnant uterus. In fact, the drug was shown to produce contraction of these structures. In the experimental observations reported herein, the discomfort induced by distention and contraction of the bladder was not relieved, nor was the tone of the bladder musculature relaxed. From this evidence it appears that calcium chloride does not bring relief of pain by producing relaxation of the smooth muscle.

The clinical cases reported here in which calcium chloride was used for the relief of pain fell into two main groups: 14 cases in which there was an irritative background and 2 with no irritative element. In the first group symptomatic relief was produced in all but 2 cases, in both of which the disease was so extensive that only large doses of morphine afforded relief. In the second group calcium chloride produced no relief. It appears that calcium chloride is effective in the patients with spasmodic pain resulting from a localized irritative state. Since calcium chloride does not produce relaxation of smooth muscle it is reasonable to assume that it acts by exerting an analgesic effect upon the nervous system. Whether it

interrupts afferent impulses or exerts its effect centrally is problematical.

Whatever its mode of action may be calcium chloride is a valuable drug for the relief of spasmodic pain. It acts promptly. It is a diagnostic aid in that when the pain is relieved, the marked voluntary muscular spasm which accompanied the pain is relaxed. This permits more careful examination of the patient without the generalized sensory depression which is brought about by morphine or its derivatives.

SUMMARY

1. The effectiveness of calcium chloride in the relief of colic like visceral pain has been demonstrated.

2. Calcium chloride is contra indicated in digitalized patients.

3. Calcium chloride was found to have no effect on the tone or contractions of the human bladder.

4. A suggestion for its mode of action has been offered.

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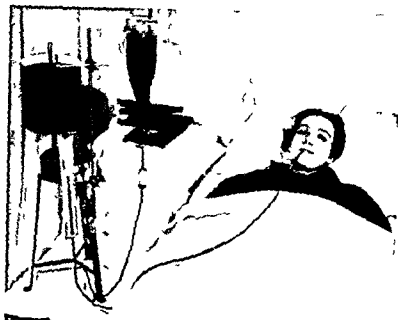


Fig. 1. An apparatus for measuring changes in intraduodenal pressure

within the duodenum, we were able to demonstrate clearly that the results obtained using the open tube, were identical to those obtained when using the balloon (Fig. 2)

In some cases roentgenological studies were made by injecting a suspension of barium into the duodenum through the duodenal tube. When resistance to injection was noted, a roentgenogram was taken when no resistance to the injection was experienced, as is usually the case with normal subjects. 40 cubic centimeters of the barium suspension were injected. Duodenal motility was observed fluoroscopically in a few cases. In other cases, patients who had had a T tube inserted in the common duct for prolonged biliary drainage kindly consented to serve as subjects for simultaneous studies on the behavior of the sphincter and the duodenum.

RESULTS

Studies were made in three groups of cases, and 25 determinations of intraduodenal pressure were made on 17 subjects. Group 1 consisted of 6 normal individuals who served as controls. Group 2 consisted of 5 patients who

had suffered from repeated attacks of postcholecystectomy biliary colic unaccompanied by jaundice, chills or fever, in these cases attacks of pain could be induced by the subcutaneous administration of $1/6$ grain (0.01 gm) of morphine sulphate, and these attacks could then be completely and consistently relieved by the sublingual administration of $1/100$ grain (0.0006 gm) of glyceryl trinitrate. Group 3 consisted of 6 patients who had suffered unusually severe and frequent attacks of postcholecystectomy pain which had been relieved by the administration of glyceryl trinitrate only occasionally, partially or not at all.

Group 1 (normal persons) The intraduodenal pressure of normal persons ranged from minus 30 millimeters of water to zero, zero being designated as the point of the manometer on a level with the xiphoid process when the patient was in the recumbent position. Tracings of the duodenal movements in such cases showed two types of wave. One type consisted of short, small waves about 1 millimeter in height corresponding in time to respiratory movements; the second was made

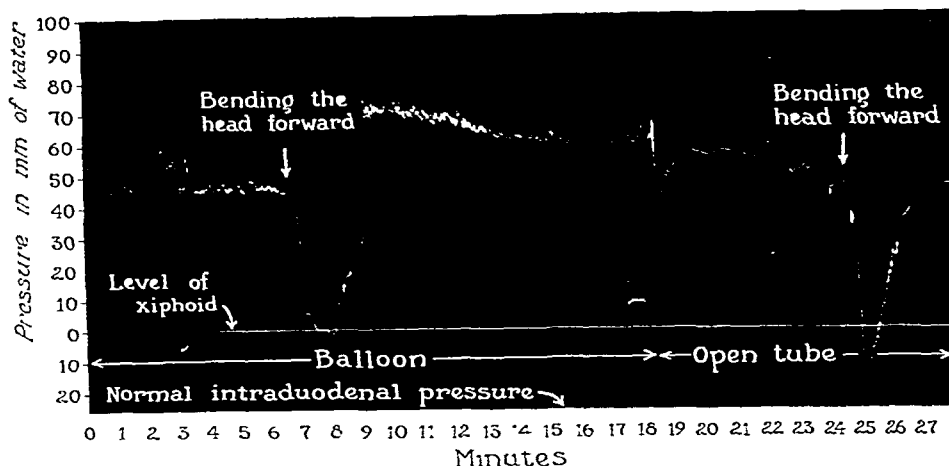


Fig 2 Tracing showing reduction of intraduodenal pressure on bending the head acutely forward. In this case two tubes were inserted into the duodenum, one open and one with a rubber bag on the end. The pressure tracing from each is essentially the same.

up of longer waves independent of respiratory excursions. These last mentioned waves corresponded to a 5 millimeter increase in pressure and lasted from a half to two minutes. An increase in intra-abdominal pressure produced coughing or straining but increased the intraduodenal pressure to only a relatively small degree (10 mm of water or less).

Group 2 (patients with biliary dyskinesia). The 5 patients in this group had suffered repeated attacks of postcholecystectomy colic, this was described as pain in the right upper quadrant of the abdomen that was projected around the right subcostal margin and into the right scapular region. As has been said, pain could be induced in these cases by morphine sulphate and relieved by nitrites. Three of these patients were studied after their common bile ducts had been drained surgically by means of T-tubes. Perfusing the common bile duct at pressures of from 50 to 200 millimeters of water produced pain described by the patient as being of the same nature as that ordinarily suffered during spontaneous colics, whereas opening the T-tube, even during the attacks of spontaneous pain, gave relief. The intraduodenal pressure in these 3 cases varied from minus 50 millimeters of water to zero (zero being at xiphoid level), the average pressure was minus 35 millimeters. In other words, the resting values for intraduodenal pressure

did not differ materially from those of patients in the normal group.

These studies of intraduodenal pressure were made only during periods of freedom from pain; it seems probable that if they had been determined during attacks of pain, higher pressures would have been found. The results of studies made after the administration of morphine to a third group of patients bore out this contention.

Group 3 (patients with intractable biliary dyskinesia) This group comprised 6 patients who, following cholecystectomy, complained of pain confined to a point in the epigastrium just to the right of the midline; this pain was not projected, although occasionally it ran straight through to the back. Amyl nitrite did not relieve the pain in these cases. Three of these patients were studied while a T-tube was present in the common bile duct. Perfusing the common bile duct with saline solution at pressures up to 500 millimeters of water did not produce pain, although a feeling of fullness and distress was noted. The resting values for intraduodenal pressure in these cases were higher than those for either of the 2 other groups, and they ranged from 20 to 100 millimeters above the xiphoid level (that is, plus 20 to plus 100 millimeters of water, or an average of plus 58 millimeters). In 2 of these 3 cases attacks of pain developed while

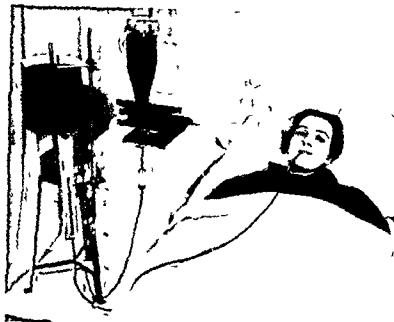


Fig 1 An apparatus for measuring changes in intraduodenal pressure

within the duodenum, we were able to demonstrate clearly that the results obtained, using the open tube were identical to those obtained when using the balloon (Fig 2)

In some cases roentgenological studies were made by injecting a suspension of barium into the duodenum through the duodenal tube. When resistance to injection was noted, a roentgenogram was taken, when no resistance to the injection was experienced, as is usually the case with normal subjects, 40 cubic centimeters of the barium suspension were injected. Duodenal motility was observed fluoroscopically in a few cases. In other cases, patients who had had a T tube inserted in the common duct for prolonged biliary drainage kindly consented to serve as subjects for simultaneous studies on the behavior of the sphincter and the duodenum.

RESULTS

Studies were made in three groups of cases and 25 determinations of intraduodenal pressure were made on 17 subjects. Group 1 consisted of 6 normal individuals who served as controls. Group 2 consisted of 5 patients who

had suffered from repeated attacks of postcholecystectomy biliary colic unaccompanied by jaundice, chills, or fever, in these cases attacks of pain could be induced by the subcutaneous administration of $1/6$ grain (0.01 gm) of morphine sulphate, and these attacks could then be completely and consistently relieved by the sublingual administration of $1/100$ grain (0.006 gm) of glyceryl trinitrate. Group 3 consisted of 6 patients who had suffered unusually severe and frequent attacks of postcholecystectomy pain which had been relieved by the administration of glyceryl trinitrate only occasionally partially, or not at all.

Group 1 (normal persons) The intraduodenal pressure of normal persons ranged from minus 30 millimeters of water to zero zero being designated as the point of the manometer on a level with the xiphoid process when the patient was in the recumbent position. Tracings of the duodenal movements in such cases showed two types of wave. One type consisted of short small waves about 1 millimeter in height corresponding in time to respiratory movements, the second was made

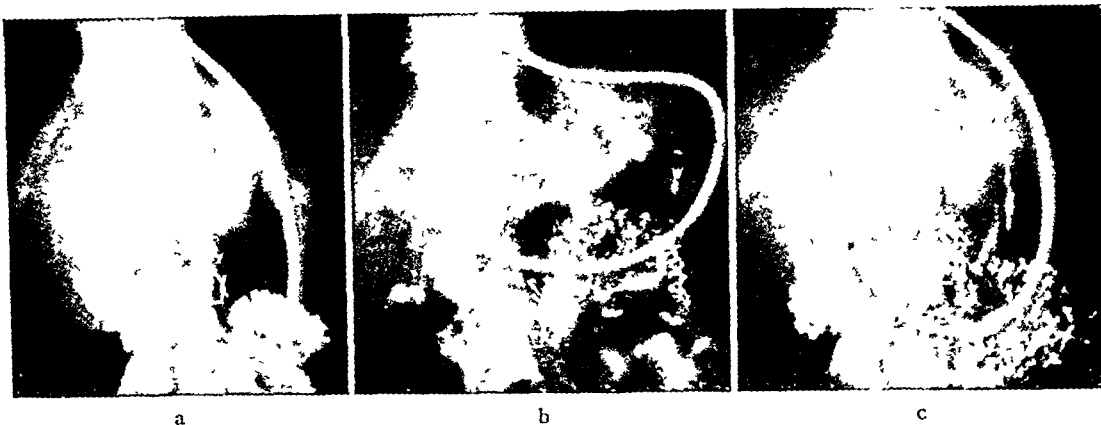


Fig 4 Duodenum of a patient with a persistently high intraduodenal pressure: a, Resting state showing obstruction in third portion and some spasm in second portion, closing it partially, b, same patient 10 minutes after administration of morphine sulphate, the second portion of

the duodenum having been closed completely by more spasm, and c, same patient following inhalation of amyl nitrite, the duodenum is again relaxed but there is a persistent narrowing in the second portion and a persistence of obstruction at the duodenojejunal junction

phine, on the other hand, affects the duodenum of these patients, a point which will be discussed subsequently in this paper.

Patients with the severe and intractable forms of biliary dyskinesia have been shown to have a high resting value for intraduodenal pressure which is greatly increased during attacks of pain. In 1 case (Fig 4) there was not only a high intraduodenal pressure, but a resting intrabiliary pressure in the common duct of 150 millimeters of water (the normal value being 0 to +10 mm of water). Amyl nitrite had only a slight effect on this pressure, and an unusually large dose was required to produce even a moderate effect.

The elevated resting value for intrabiliary pressure in such cases of intractable biliary dyskinesia may be explained partly on the basis of associated duodenal spasm and partly on the basis of associated fibrosis, inflammation, or edema of the wall of the duct and of the sphincter itself. The fact that glyceryl trinitrate has given relief from pain in some cases and not in others may eventually be explained on the basis of some underlying organic change in the wall of the duct, in the sphincter, or in the duodenum in the intractable case. In 3 such cases patients have been completely relieved by placing a T-tube in the common bile duct and instituting prolonged biliary drainage. One other patient acciden-

tally pulled out the T-tube after 5 weeks' drainage and, a few weeks later, the pain returned; at first it was mild, and then it gradually became more severe. Operation was subsequently performed, replacing the tube and complete relief was again obtained.

A duct which is dilated and thin-walled probably withstands increased pressure poorly, T-tube drainage allows a dilated common bile duct to return to its normal size. This fact was borne out in a series of studies on intrabiliary pressure made at varying periods after the insertion of a T-tube into the common bile duct. Three weeks following operation, perfusion of the common bile duct with physiologic saline solution at a pressure of 150 millimeters of water produced pain, whereas 2 months later, the patient's common duct was able to withstand pressures of 500 millimeters of water without distress. Roentgenograms made by injecting the common bile duct with brominol, according to the method of Walters and Thiessen, showed the presence of a dilated common bile duct on the earlier date and a normal sized duct 2 months later. The persistently high, resting value for intraduodenal pressure in these cases of intractable biliary dyskinesia argues for a local source of irritation which induces spasm of the duodenal musculature; this may also influence intrabiliary pressure, as will be shown later.

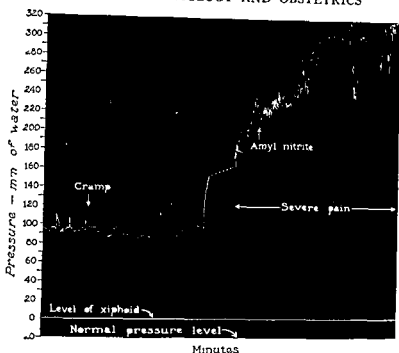


Fig 3. Tracing obtained in a case in which the patient had a high resting value for intraduodenal pressure showing a further increase in pressure during an attack of pain.

studies of duodenal pressure were being made in each case the intraduodenal pressure rose above an average value of 90 millimeters to a level of 350 millimeters of water (Fig 3). In the third case perfusing the common duct at a pressure of 150 millimeters of water produced pain, whereas perfusing the duodenum at a pressure of 500 millimeters or more of water did not produce discomfort. In still a fourth case without a T tube in the common duct perfusing the duodenum produced only head ache.

Röntgenograms of the duodenum of 2 of these patients with abnormally high intra duodenal pressures showed the presence of some form of resistance to the flow of barium from the duodenum into the jejunum (Fig 4 a) the barium in the third portion of the duodenum seeming to stop short at a point opposite the vertebral column. Figure 4 b also shows narrowing of the second portion of the duodenum suggesting a moderate degree of local muscle spasm. Figure 4 c shows that this spasm can be partially relaxed by the inhala-

tion of amyl nitrite. In this case however, there was some evidence of constriction of the second and third portions of the duodenum even after the administration of amyl nitrite.

THE NATURE OF POSTCHOLECYSTECTOMY COLIC

The nature of postcholecystectomy colic, or if one prefers 'biliary dyskinesia' may now be considered in light of these findings. It appears that in the ordinary case in which the condition is characterized by occasional colics there is moderate sensitivity to morphine and relief from nitrites but there is a constant change in the behavior of the duodenum the site of the difficulty presumably being an irritable and hyperactive sphincter of Oddi. That duodenal contractions accompany prolonged spasm of the sphincter can hardly be disputed especially in view of Westphal's observations we had however no opportunity to study a patient during an attack of spontaneous pain. The important thing is that the duodenal spasm does not persist in such cases. Mor-



Fig 6 Serial roentgenograms after simultaneous injection of the common bile duct with brominol through a T-tube and of the duodenum with barium. a, at rest, b, 10 minutes after administration of morphine sulphate, showing

spasm of duodenum and reflux of medium into the finer radicles of the biliary tree, and c, after inhalation of amyl nitrite, showing relaxation of duodenal spasm and decrease in amount of medium in the bile ducts

METHODS OF REDUCING INTRADUODENAL PRESSURE

Two methods of reducing intraduodenal pressure were found (1) pressure applied to the neck in the region of the carotid sinus, and (2) moderate sized doses of insulin

Stimulating the endings of the vagus nerve in the neck by such procedures as bending the head acutely forward, by pressure over the carotid sinuses, or by electric stimulation over the left carotid sinus, produced a marked reduction in intraduodenal pressure on 15 occasions in 5 individuals; such stimulation produced a fall of from plus 148 to plus 30 millimeters of water in 1 case. Insulin in doses of 20 to 30 units was used on 3 occasions in 1 case and on 2 occasions in another, its administration reduced an elevated intraduodenal pressure from around plus 65 to plus 10 millimeters of water. This effect began 15 minutes after the insulin was given and progressed for from 35 to 45 minutes thereafter. Pressure rose in each case following the intravenous administrations of glucose. What the significance of these findings is we do not know. Such procedures produce no result on the intraduodenal pressure of normal individuals for the obvious reason that there is no resistance to the flow of fluid at the lower end of the duodenum and the pressure is already low.

APPLICATION OF METHODS

The methods described for lowering intraduodenal pressure, namely, administering insulin and applying pressure over the carotid sinus or vagus nerve in the neck, will require further investigation to determine whether the decrease in duodenal pressure is due to relaxation of the pylorus or of the distal part of the duodenum. Schmidt and one of us (McGowan) has demonstrated a similar relaxation of the normal human cardia by means of these methods.

The duodenum of a young girl with a roentgenologically normal gall bladder was studied fluoroscopically during an attack of biliary colic. Through a Sawyer tube a suspension of barium was injected slowly into the duodenum while it was observed under the fluoroscope. Marked spasm was present in the second portion of the duodenum, similar to that represented in Figure 4, b. At intervals, a small bolus of barium, representing 3 to 5 cubic centimeters measured on the injecting syringe, would pass down through the spastic second portion of the duodenum. When it reached the point where the duodenum joined the jejunum, it would encounter an antiperistaltic wave which forced it back into the stomach. Following the inhalation of amyl nitrite this situation was entirely changed, the

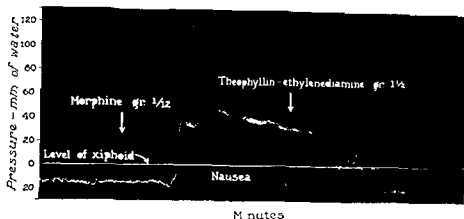


Fig 5 Tracing of intraduodenal pressure in a normal person showing effects of administration of morphine sulphate

THE ACTION OF MORPHINE ON THE DUODENUM

Following the subcutaneous injection of 1/6 grain (0.01 gm) of morphine sulphate to a mixed group of normal subjects and patients with postcholecystectomy colic the intraduodenal pressure rose in 10 cases from an average of minus 17 to plus 41 millimeters of water after a period of from 3 to 15 minutes (Fig 5).

In patients with postcholecystectomy colic, roentgenological studies made 10 minutes after the injection of morphine showed spasm of the second portion of the duodenum. The outline of the first portion as well as that of the pyloric sphincter remained unchanged (Fig 4, b). A series of roentgenograms made after simultaneously injecting the common bile duct and duodenum in one of our "intractable cases" showed that when the duodenum contracted following an injection of morphine the lower end of the common bile duct was sharply obstructed and the opaque medium was forced up into the radicles of the biliary tree (Fig 6). Here the closed lower end of the common bile duct and the duodenal musculature are so intimately associated that the sphincter of the common bile duct can hardly be differentiated from that constriction produced by contraction of the muscle of the duodenal wall. The possibility that morphine acts on the duodenum and on the sphincter of Oddi simultaneously must of course be admitted. The reaction of the duodenum to morphine so far as roentgenological and pres-

sure changes are concerned, was essentially identical in normal subjects and in patients with occasional colic but the reaction to morphine seemed most pronounced in patients with intractable biliary dyskinesia.

METHODS OF REDUCING DUODENAL PRESSURE

In order for an elevated pressure to exist within the duodenum, some form of resistance to the free flow of fluid in either direction must be postulated. Roentgenograms taken in cases with normal resting values for intraduodenal pressure showed that the barium tended to run freely down the bowel and up to the pyloric sphincter but that it rarely ran into the stomach, hence the resistance offered by pyloric tonus is greater than that encountered in the lower portion of the duodenum.

In other cases with high resting values for intraduodenal pressure there was roentgenological evidence which indicated some form of resistance to the flow of barium from the duodenum to the jejunum (Fig 4, a and b).

In such cases a rapid reduction in pressure could be due either to relaxation of the duodenal musculature or to relaxation of the pylorus. The present studies do not furnish evidence which would allow for definite differentiation. We have not been able to determine whether the decreased pressure is due to relaxation of the pylorus or to a decrease in the resistance offered to the flow of fluid from the duodenum to the jejunum.

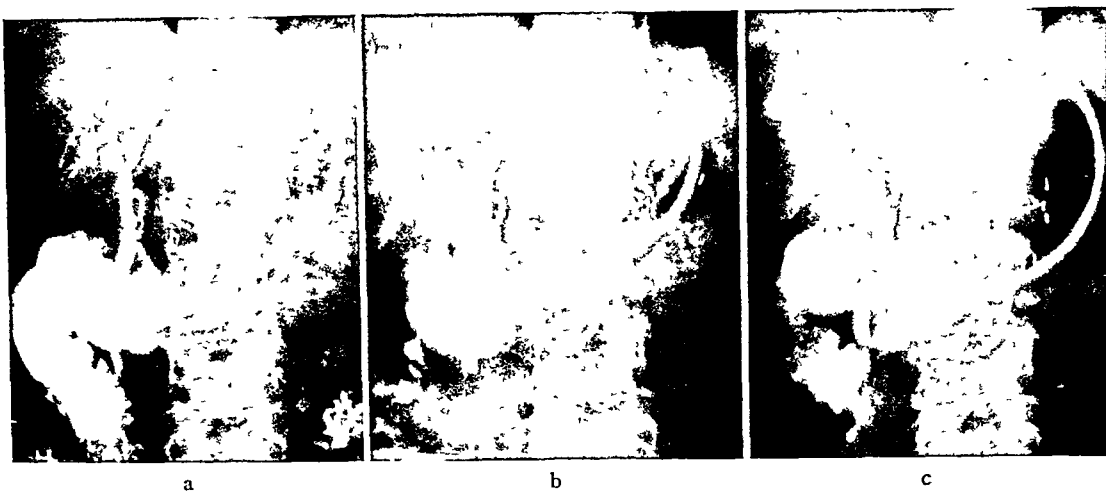


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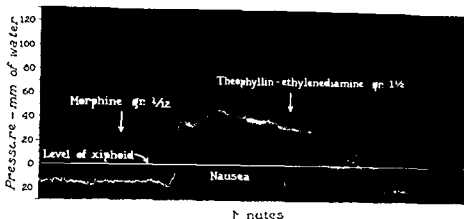


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The evidence presented indicates the importance of studying duodenal motility in cases of intractable biliary colic and the desirability in such cases of searching for some organic change in the common duct, sphincter, or in the duodenal wall itself.

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A NOTE ON THE RESPIRATION-LIKE MOVEMENTS OF THE HUMAN FETUS

W. F. WINDLE, Ph D, C. A. DRAGSTEDT, Ph D, M D, D. E. MURRAY, M.B., and R. R. GREENE, M D., Chicago, Illinois

IT is well known that the breathing mechanism is developed before birth and that premature interruption of a pregnancy does not necessarily lead to death of the fetus for want of functional lungs. Furthermore, the fetus occasionally executes rhythmic respiratory movements spontaneously *in utero* shortly before birth. Ahlfeld (1905) published very convincing graphic records of such activities and Snyder and Rosenfeld (1937) have demonstrated them cinematographically.

Although incidental mention of respiratory-like movements of the human fetus at artificial abortion, hysterectomy, or hysterotomy has been made by a number of investigators, very few reports concern the fetus in the first

half of gestation. The youngest specimens have been described by Erbkam (1837) and Minkowski (1922). The former saw a fetus of about 4 months (170 mm crown-heel length) open its mouth as though to breathe. The latter reported deep inspiratory movements of the thorax with the mouth opening and the elevation of the arms in one of 180 millimeters crown-heel length. Strassmann (1903) expressed the opinion that the first human fetal movement is an elevation of the arms as in taking a breath but he cited no evidence for his belief. Hooker (1936) stated that respiration was about the only specific activity not represented in at least an imperfect stage at 14 weeks (121 mm crown-heel length).

Because so little is known about early prenatal respiratory activity and because the subject is receiving attention in several experi-

whole of the duodenum filling evenly with barium. At intervals a constricting band would appear at the junction of the first and second portions of the duodenum and pass leisurely downward, pushing in front of it a generous quantity of barium over into the jejunum. Similar studies were made later on another patient, during periods of freedom from pain. There was then no evidence of spasm in the duodenum and the barium passed readily into the jejunum.

Two other patients were also studied roentgenologically. They had had persistent postcholecystectomy biliary colic, associated with repeated attacks of vomiting existing respectively, for 8 and 10 years. Glyceryl trinitrate relieved the pain only partially. Marked narrowing of the duodenum was found in each case. One of these patients was subsequently operated on and a tube was placed in the common bile duct for prolonged drainage. Her pain was promptly relieved but the vomiting continued for 2 weeks subsiding only completely one month after operation. At this time roentgenograms were taken following the injection of the common bile duct with brominol and the duodenum with barium. These showed narrowing of the second portion of the duodenum. The common bile duct was dilated, and narrowed at the lower end where it joined the duodenum.

The foregoing observations while by no means complete and therefore insufficient to warrant any sweeping conclusions do appear to incriminate the duodenal musculature as a factor in the production of some of the symptoms of biliary colic. While the pain itself may not necessarily depend upon such a state of duodenal contraction, it is probable that the nausea, vomiting, fullness and epigastric distress may be related to the irritable or spastic state of the duodenum. The nausea and vomiting which so often follow the administration of morphine are probably due to vigorous contractions of an already spastic musculature. Furthermore evidence is offered to show that, in intractable biliary dyskinesia the duodenal motility is altered sufficiently to produce of itself certain symptoms. In such cases there is some interference with normal duodenal emptying due to an apparent con-

tracting ring at the duodenojejunal junction. One would not be justified in assuming on the basis of the evidence presented that altered duodenal motility is a pathognomonic sign of intractable biliary dyskinesia, but it does appear that duodenal hyperirritability plays a definite role in the persistence of symptoms in such cases. In other words the behavior of the duodenum deserves further study in these intractable cases, since its continued spastic state argues for a possible reflex or local cause of organic nature. In distinction to these cases one may cite cases of transient and easily relieved colics of simple biliary dyskinesia in which intraduodenal pressures are normal.

SUMMARY AND CONCLUSIONS

A method for studying the activities of the duodenum has been presented which consists of measuring changes in pressure in the duodenum by means of an ordinary open Sawyer duodenal tube and a water manometer. After injecting a mixture of barium and water directly into the duodenum through the tube roentgenograms were taken of the duodenum under various phases of changes in pressure. Morphine produced an increase in intraduodenal pressure, apparently due to spasm of its second portion. Amyl nitrite relaxed this spasm. Roentgenograms taken by simultaneously injecting brominol into the common bile duct through a previously inserted T tube and by injecting barium into the duodenum through a Sawyer tube showed that the spasm of the duodenum produced by morphine seems also to involve the lower end of the common bile duct.

Resting values for intraduodenal pressure were determined in 3 groups of cases. Patients suffering from repeated attacks of postcholecystectomy biliary colic capable of relief by nitrites were found to have intraduodenal pressures of from minus 35 to minus 50 millimeters of water. In normal subjects pressures of minus 30 to 0 millimeters of water were encountered. In individuals with intractable postcholecystectomy colic not relieved by nitrites and presenting roentgenological evidence of obstruction of the third portion of the duodenum the resting values for intradu-

denal pressure were between plus 30 and plus 100 millimeters of water. In patients with abnormally high intraduodenal pressures, stimulation of the carotid sinus or moderate doses of insulin produced a moderate reduction in pressure; this was of a temporary nature, however, and did not give any constant relief from pain.

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Because so little is known about early prenatal respiratory activity and because the subject is receiving attention in several experi-

mental laboratories at the present time, it seems desirable to report observations in three new specimens smaller than any that have been described previously.

Several years ago one of us (C A D) had the opportunity to observe the behavior of a 4 month old fetus of about 140 or 150 millimeters crown heel length. Pregnancy was terminated for therapeutic reasons by dilating the cervix, the specimen with its placenta was delivered promptly. It was soon seen to be executing rhythmic movements of the head and trunk which involved contractions of the diaphragm and chest muscles. These inspiration like activities were strong and resembled rhythmic gasping. They continued for many minutes, becoming slower after they were first noticed.

On another occasion (observed by D E M and R R G) a gravid uterus was obtained,¹ taken to a room adjoining the operating theater and opened approximately 3 minutes after the blood vessels had been clamped. The fetus was freed from its membranes and the umbilical cord was severed. At this time rhythmic movements of thoracic and abdominal muscles resembling rapid breathing were seen. They occurred periodically for about 3 minutes. Occasionally the fetus threw back its head as though to gasp and with this movement the costal margin was elevated. The specimen measured 70 millimeters crown rump

length, 85 millimeters crown heel length. Eighty four days had elapsed since the last menstruation.

Again more recently a fetus of 62 millimeters crown rump length and 85 millimeters crown heel length was obtained (by R R G) at hysterectomy. The last menstruation had begun 84 days previously. Three distinct respiratory movements were seen in the first 3 minutes of observation. Contralateral arm reflexes followed tapping the arm but no responses were obtained from the legs.

It is evident from these observations that the human fetus can execute rhythmic respiratory like movements in the third and fourth months. That they do so normally *in utero* is not implied, because in every instance a state of anoxemia with carbon dioxide accumulation had been set up in the fetus by removal from the uterus. Observations in other forms of mammals and in birds (W F W, unpublished) indicate that such activities do not appear until late in fetal life unless the oxygen exchange mechanism is disturbed.

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¹On the service of Dr H O Jones at St Luke's Hospital, Chicago.

THE EFFECT OF LIGHT ON BENZOPYRENE CANCER IN MICE

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ALTHOUGH it has long been assumed that light is a factor in the production of skin cancer in man, until recent years little experimental evidence has been adduced to support or deny this conclusion. The study of the rôle of light in the production of carcinoma has of late received increasing attention and the problem has been approached from many angles. Some workers have merely subjected experimental animals to light from various portions of the spectrum. For example, Finlay exposed mice to the rays of a quartz mercury-vapor lamp and found that after 8 months papillomas and malignant epitheliomas appeared. Tarred animals exposed to ultraviolet light developed carcinoma in a shorter time than when either tar or violet ray exposure was used alone. Herlitz, Jundell and Wahlgren, using mice, and Putschar and Holtz, using rats, were able to produce more carcinomas in the animals exposed to ultraviolet light than in unexposed controls. On the contrary, Rathman and Bernhardt, using rabbits, were unable to produce carcinoma after repeated exposure to ultraviolet rays, and Kohn-Speyer could not produce tar tumors in mice more quickly by the additional use of ultraviolet light. Thus, this line of approach has given quite contradictory results.

Other workers have attempted an opposite approach to the problem in that they subjected experimental animals to a complete absence of light. Dodds, Bang, Lipschuetz, Schorr and Ssobolewa, Vlès, de Coulon and Ugo, and Seelig and Cooper, are among the workers who have attempted experimental studies on the effect of total darkness on the production of carcinoma. The conclusions from these studies have also been contradictory.

A third line of approach has been the study of the effect of certain so-called light sensi-

tizing agents on experimental carcinogenesis. Various agents have been used in an attempt to produce light sensitivity in animals, the most important of which in connection with our studies are cholesterol and hematoporphyrin. Roffo and his co-workers believe that a relationship exists between the photoactivity of cholesterol and cell function, that sunlight serves to fix the cholesterol in the tissues and that cholesterol then becomes an organic accumulator of light. The cholesterol which he believes becomes photoactive as a result of oxidation by light is thought to play an important rôle in the production of carcinoma. Hausmann has perhaps done the greatest amount of work upon the use of hematoporphyrin as a light sensitizing agent. It has been found that mice injected subcutaneously with hematoporphyrin and kept in the dark show no peculiar effects of the drug; however, when these animals are exposed to light their ears, noses, and paws become markedly hyperemic and after sufficient exposures a marginal necrosis of the ears may develop. The drug also apparently produces an intense itching of the skin, for the mice scratch almost constantly during the period of exposure to light. Rothmund has also made extensive studies upon the physiological effects of hematoporphyrin and other light sensitizing substances, such as certain derivatives of chlorophyll. However, not much work has been done on the use of these chemicals with relation to carcinogenesis. Buengeler has studied the effect of the injection of various light sensitizing agents, such as eosin, anthrasol, and hematoporphyrin on the production of tar cancer in mice, and has found that these substances which increase the light sensitivity of the experimental animals seem also to increase their susceptibility to tar cancer. However, work upon this phase of the problem of the rôle of light in the production of carcinoma is still in its infancy and the results are as yet not clear cut.

From the Research Department of the Barnard Free Skin and Cancer Hospital

This study was aided by a grant made in honor of the memory of Robert G. Blumenthal

TABLE I—AUTOPSY FINDINGS IN THE MICE KILLED AT THE END OF 26 WEEKS

Group receiving benzpyrene and exposed to light		Group receiving benzpyrene and kept in the dark	
No.	Microscopic findings upon examination of neck lesions	No.	Microscopic findings upon examination of neck lesions
23	Cancer	23	Hyperplasia
24	Cancer	24	Cancer
25	Cancer	25	Cancer
26	Cancer	26	Hyperplasia
27	Hyperplasia	27	Cancer
28	Cancer	28	Cancer
29	Cancer	29	Cancer
30	Cancer	30	Cancer
31	Cancer	31	Cancer
32	Cancer	32	Hyperplasia
33	Cancer	33	Hyperplasia
34	Cancer	34	Cancer
35	Cancer	35	Cancer
36	Cancer	36	Cancer
37	Cancer	37	Hyperplasia
38	Cancer	38	Hyperplasia
39	Cancer	39	Cancer
40	Hyperplasia	40	Cancer
41	Cancer	41	Cancer
42	Cancer	42	Hyperplasia
43	Cancer	43	Hyperplasia
44	Cancer	44	Cancer
45	Cancer	45	Cancer
46	Cancer	46	Cancer
47	Hyperplasia	47	Cancer
48	Cancer	48	Cancer
49	Cancer	49	Cancer
50	Hyperplasia	50	Cancer
51	Hyperplasia	51	Cancer
52	Hyperplasia	52	Cancer
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91	Hyperplasia	91	Cancer
92	Hyperplasia	92	Cancer
93	Hyperplasia	93	Cancer
94	Hyperplasia	94	Cancer
95	Hyperplasia	95	Cancer
96	Hyperplasia	96	Cancer
97	Hyperplasia	97	Cancer
98	Hyperplasia	98	Cancer
99	Hyperplasia	99	Cancer
100	Hyperplasia	100	Cancer

Since so much confusion exists concerning the relationship between light and carcinogenesis the present experiments were undertaken to determine (1) the effect of repeated exposures to light from a definite source upon the production of benzpyrene carcinoma in mice, and (2) the effect of this light upon the development of benzpyrene carcinoma in mice

previously made light sensitive by repeated injections of small doses of hematoporphyrin

MATERIALS AND METHODS

One hundred and fifty female mice were used in these experiments. The animals were obtained from the Rockland Farms, New York City, and belonged to the Rockland all purpose strain, which has been inbred for 35 generations. At the beginning of the experiment all of the animals were 3 to 4 months old. The mice were divided into three groups of 50 each. All of the groups were housed in standard metal cages which except during the experimental procedures were kept in a compartment darkened with black paper. One drop of a 0.5 per cent solution of benzpyrene (Union Chimique Belge) in benzol was applied twice weekly to the skin on the back of the necks of all the mice for a period of 6 months. In addition, the animals in one group of 50 mice were injected subcutaneously on the rump 6 times (at 4-day intervals) with 0.3 cubic centimeter of a solution of hematoporphyrin prepared by dissolving 0.1 gram of hematoporphyrin in 2.5 cubic centimeters of tenth normal sodium hydroxide and diluting the mixture to 100 cubic centimeters with distilled water. After six injections this procedure was discontinued, because of the high mortality due to the toxicity of the hematoporphyrin. This group and a second group of 50 mice, which were simply painted with benzpyrene were exposed for 1 hour daily for 6 months to the light from a General Electric Type S1 sun lamp 600 glass bulb. This lamp transmits a band of rays between 2894 and 5500 Angstrom units (thus including rays from the ultraviolet and from the visible spectrum). This lamp according to the General Electric Company's supplies approximately 10,000 "E vitamins" and takes about 7 minutes at a distance of 30 inches from the lamp to produce an immediate slight reddening of the skin in humans. The mice were exposed to the lamp in a cage measuring 20 inches in length by 20 inches in width and 6 inches in height, made of 1/2 inch mesh wire screen. The cage was divided by similar

We are deeply indebted to the General Electric Company for their fine co-operation in this research.

screening into 25 compartments, each measuring 4 by 4 inches. Not more than 2 mice were placed in each compartment during the period of exposure. The cage was placed upon a white enameled metal base to insure a maximum reflection of light. The center of this base was always placed 36 inches below the bulb of the lamp.

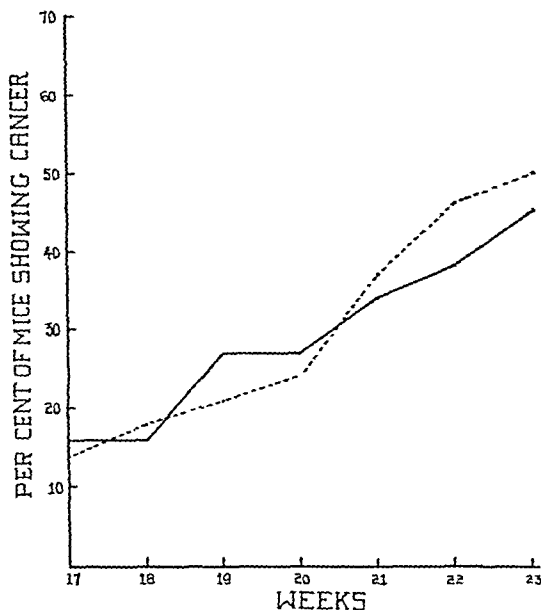
The third group of 50 mice, which were used as controls, were kept constantly in the darkened compartment.

During the 6-month experimental period, the necks of all of the mice were carefully examined once a week for gross evidence of carcinoma at the site of benzpyrene application. The thickness and hardness of the lesion, the depth and width of the infiltration, and the shape of the pearly border were noted. When the border was approximately 3 millimeters thick, when the induration was woody hard and extended over an area at least 1 centimeter in diameter, and involved the subcutaneous tissue, and when the edge of the lesion had a typical pearly appearance, a diagnosis of carcinoma was made.

The control mice, which died during the course of the experiment, were subjected to autopsies and the areas on the backs of the necks which had been treated with benzpyrene were removed for sectioning and microscopic study. Thus, a rigid control was maintained against the purely tentative clinical diagnoses of carcinoma. At the end of 6 months all the mice remaining alive were killed with ether and likewise subjected to autopsies. Microscopic sections of the lesions on their necks produced by the application of benzpyrene were also made. Sections were stained routinely with hematoxylin and eosin, and with Van Gieson's stain for connective tissue.

DISCUSSION

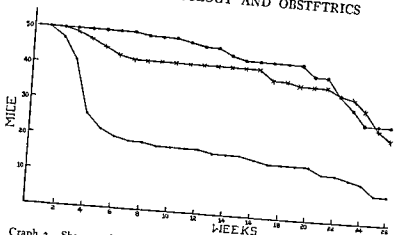
The first definite clinical or gross evidence of carcinoma was observed in both the experimental and the control mice at the beginning of the seventeenth week of the experiment. At that time, basing our conclusions on the gross factors of thickness and hardness of the lesion, degree of infiltration, and appearance of the border, 14 per cent of the animals painted with benzpyrene and exposed



Graph 1—Showing the percentage of mice developing carcinoma after the 17th week of the experiment
 Group of mice kept in the dark and painted with benzpyrene
 Group of mice exposed to light and painted with benzpyrene

daily to the sun lamp and 16 per cent of the controls which were painted with benzpyrene and kept in the dark, showed evidence of carcinoma. From that time until the end of the experiment the percentage of malignancy rose about equally in both groups until the twenty-third week, at which time 50 per cent of the experimental animals and 45 per cent of the controls had apparently developed carcinoma. A curve showing the increasing percentage of mice developing carcinoma in the two groups during the latter part of the experimental period is shown in Graph 1.

The mortality during the course of the experiment was rather high in all groups of mice. Graph 2 presents a mortality curve for all of the animals used in the experiment. Of the group of animals which were painted with benzpyrene and exposed daily to the sun lamp, 22 died before the end of the experiment. Of these 10 animals were found to have developed carcinoma (proved by microscopic section). Among the controls, which were painted with benzpyrene, but kept in the



Graph 2—Showing the mortality rate in the three groups of mice used in the experiment
 —●— Group exposed to light and painted with benzpyrene
 —×— Group exposed to light injected with hematoporphyrin and painted with benzpyrene
 —○— Group kept in the dark and painted with benzpyrene

dark, 26 animals died during the course of the experiment and of these 13 developed carcinoma. Thus 45.4 per cent of the experimental animals and 50 per cent of the control animals, dying during the course of the experiment developed carcinoma. The difference in the incidence of carcinoma in the two groups is quite insignificant.

Of the group exposed daily to the sun lamp 28 were still alive at the end of 6 months and of the controls 23 were living at the end of the same period. These animals were killed at autopsies were performed, and microscopic sections prepared of the areas on the neck. Twenty-three, or 82.1 per cent of the experimental animals and 17, or 73.9 per cent, of the controls were found to have carcinoma. Table I presents an analysis of the autopsy findings in these two groups of mice. Because of the relatively small number of animals in the two groups this difference is suggestive rather than significant.

The group of 50 mice which were given injections of hematoporphyrin, furnished very little reliable data concerning the relation of light sensitivity to the development of benzpyrene carcinoma. The hematoporphyrin proved to be highly toxic and after 6 injections the use of the drug was discontinued. The mortality in this group was very high.

Twenty-one of these mice died during the first month of the experiment, the period during which hematoporphyrin was being given. The mortality rate of this group as compared with the controls is given in Graph 2. Only 4 of the mice that died during the course of the experiment developed carcinoma. At the end of 6 months when the animals remaining alive in all groups were killed and examined, only 7 of this group were still alive. Upon microscopic examination of the lesions on the necks of these animals, all but one of them were found to have carcinoma. Because of the high mortality in this group occasioned by the toxicity of the hematoporphyrin these results are only suggestive. This study of the effect of light sensitizing substances upon benzpyrene cancer in mice is to be continued.

SUMMARY

The incidence of skin cancer in mice treated with benzpyrene was studied in a group of 50 mice exposed to a sun lamp and contrasted with the incidence in a similar group kept in the dark.

The difference in the incidence of skin cancer in the two groups was found in our judgment, not to be sufficiently marked to warrant drawing dogmatic conclusions.

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THE CONCENTRATION OF SERUM SULPHATE AND BLOOD UREA IN PROSTATIC HYPERTROPHY ASSOCIATED WITH URINARY OBSTRUCTION

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ORDINARY tests of renal function at times may be of limited value in the estimation of renal function in cases in which retention of urine is associated with prostatic hypertrophy. There are several reasons for this regrettable fact. A patient afflicted with an enlarged prostate gland may have kidneys which have inadequate functional ability as the result of changes secondary to a renal arteriosclerosis which existed prior to the onset of urinary obstruction, while another patient may have had sound kidneys prior to the onset of urinary obstruction but renal insufficiency may develop as a consequence of the obstruction of the urinary stream. Obviously, all possible gradations and variations between these two extremes will be found in practice. It is a well known fact that the excretion of phenolsulphonphthalein may be normal or at most slightly decreased at the onset of acute renal insufficiency which developed from urinary obstruction in a case in which a patient had sound kidneys prior to the obstruction. In another case in which renal function was impaired as a result of renal arteriosclerosis and urinary obstruction occurs secondarily as the result of a hypertrophied prostate gland, the excretion of phenolsulphonphthalein may indicate the degree of renal insufficiency produced by these combined factors. Undoubtedly, some degree of impaired renal function which is the result of arteriosclerosis exists in cases of prostatic hypertrophy. It is the arteriosclerosis and not the recent urinary obstruction that accounts for the decreased excretion of phthalein. Occasionally when the output of urine is markedly reduced the excretion of phthalein may drop to a very low

level, only because there is insufficient excretion of water to carry the phenolsulphonphthalein through the kidney. The nitrogenous waste products also require considerable dilution for their excretion, hence, when the daily output of urine is less than 250 to 300 cubic centimeters, the concentration of non protein nitrogen of the blood may reach considerable heights.

In spite of the foregoing limitations physicians have correctly depended on the estimation of the concentration of blood urea and the determination of the excretion of phenolsulphonphthalein for the evaluation of possible renal sufficiency in cases of prostatic hypertrophy. Since so much theoretical similarity exists between the excretion of urea and phthalein the data on the estimation of excretion of phenolsulphonphthalein have been omitted from this report. In the present communication, data pertaining only to the concentration of blood urea and serum sulphate will be given.

In previous studies it has been observed that serum sulphate may be increased in cases of early renal insufficiency before either the urea is increased or the excretion of phthalein is decreased. The concentration of serum sulphate alone was increased in 19 cases (Fig. 1) in this study. The patients in these cases all had hypertension and arteriosclerosis. They had no residual urine or at most had less than 100 cubic centimeters. Clinically of course it was impossible to determine whether the nocturia and frequency of micturition which were present in these cases were symptoms of the prostatic enlargement or were attributable to the arteriosclerotic changes which resulted in a renal insufficiency. We often have seen a frank renal insufficiency develop in cases in which there was an increased concentration of

serum sulphate. However, it is not always possible to interpret the significance of an increased concentration of serum sulphate on the basis of one determination. It might well be that the patient has had some acute renal disorder which is clearing up and that subsequent determinations of the concentration of sulphate would give results which were within normal limits. So far as we know, however, an increased concentration of serum sulphate is associated with a failure of renal function.

Under certain conditions which cannot be defined, there may be an increased concentration of blood urea while the concentration of serum sulphate remains within normal limits (Fig 2). The clinical findings in the 31 cases in Figure 2 were the same as they were in the cases in Figure 1 except that hypertension was not present in all of the cases in Figure 2. However, in some there were moderately elevated blood pressures. On an average the residual urine was greater in the latter group.

The patients in the latter group of cases were of greater interest to us, first, because of the increased concentration of blood urea and the normal values for serum sulphate and, second, because of the progress the patients made while they were in the hospital. Figure 3 is a graphic representation of the value for the blood urea when fluids were administered by mouth and intravenously. The value for the blood urea rapidly returned to normal within a few days. In this figure only the value for the first determination of serum sulphate is given since subsequent values were also normal. These patients made uneventful recoveries after surgical relief of the urinary obstruction.

Usually, if there is an increased concentration of either blood urea or serum sulphate the concentration of the other is also increased (Fig 4). This figure shows that in renal insufficiency the general trend is for the concentration of both blood urea and serum sulphate to increase. However, increases of these substances in the blood do not give any definite prognostic criteria.

The subsequent course after the oral and intravenous administration of fluids in cases in which there was an increased concentration of both blood urea and serum sulphate is shown

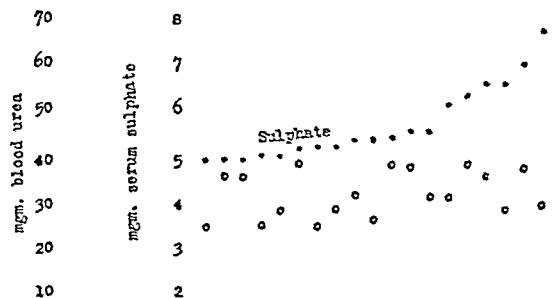


Fig 1 Increased concentration of serum sulphate and normal concentration of blood urea in 19 cases. Dots, value for serum sulphate, o, corresponding value for blood urea in same case.

in Figure 5. The administration of fluids may cause a rapid decrease in the concentration of blood urea whereas the concentration of serum sulphate is not so quickly affected. This figure shows the general tendency for serum sulphate to be less easily affected by diuresis than the blood urea. However, the concentration of serum sulphate may be lowered by a prolonged diuresis just as is the concentration of blood urea. Occasionally, we have seen a value of 7 milligrams of sulphate (23 milligrams of sulphur) per 100 cubic centimeters of serum and a value of 100 milligrams of urea per 100 cubic centimeters of blood reduced to normal values in 4 or 5 days. It is the rule, however, that a fortnight or more may be required to reduce a value of 7 milligrams of sulphate per 100 cubic centimeters of serum to normal limits.

If one includes all patients who have been admitted to The Mayo Clinic on account of prostatic enlargement of sufficient degree to require a transurethral resection of the prostate gland, it will be found that the concentration of the serum sulphate and blood urea are within normal limits. The clinical examination, however, may be no different from some of those in which there were mild degrees of renal insufficiency. It is for this reason that tests which may indicate the state of renal function are important assets in outlining the future care of the patients who have prostatic hypertrophy and urinary obstruction.

EVALUATION

During the past several years we have determined the concentration of sulphate in the

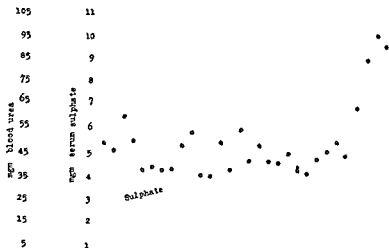


Fig. 2 Increased concentration of blood urea and normal concentration of serum sulphate in 31 cases. Dots serum sulphate values, o corresponding value for blood urea same case.

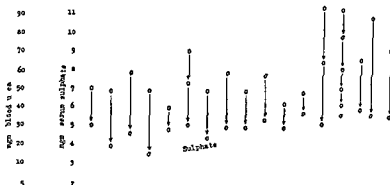


Fig. 3 Graphic representation in 17 cases of the effects of administration of fluids in cases of increased concentration of blood urea (indicated by c) and normal concentration of serum sulphate (indicated by dots).

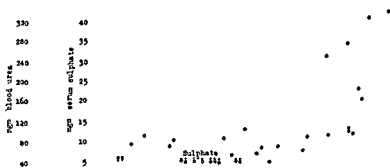


Fig. 4 Increased concentration of both blood urea (indicated by o) and serum sulphate (indicated by dots) in 70 cases.

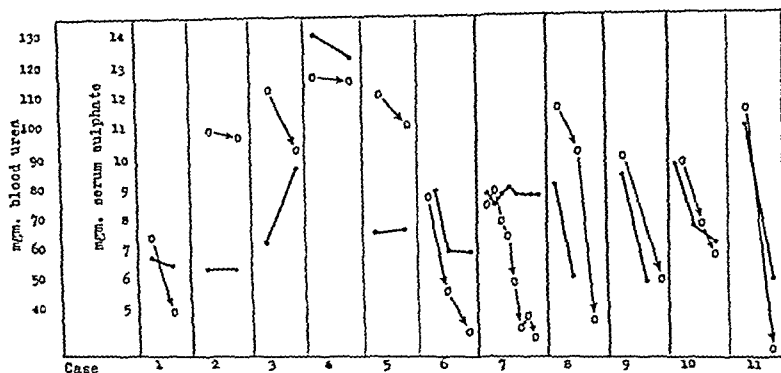


Fig 5 The effects of administration of fluids when the concentrations of blood urea (o) and serum sulphate (dots) are increased

serum in health and in disease. The concentration varies considerably among normal individuals. In series of 125 normal persons, the range of concentration of sulphates varied from 1.9 to 5.1 milligrams of sulphate (0.63 to 1.66 milligrams of sulphur) in each 100 cubic centimeters of serum. Fifty per cent of these values fell between 3.4 to 4.2 milligrams of sulphate (1.13 to 1.4 milligrams of sulphur) in each 100 cubic centimeters of serum. Statistically and for practical purposes, any value up to 5 milligrams (1.66 milligrams of sulphur) in each 100 cubic centimeters of serum is normal.

An increased concentration of serum sulphate before there is an increase in the concentration of blood urea may occur in arteriosclerotic disease of the kidney and in glomerulonephritis. This, however, is not a regular occurrence because the concentrations of these two substances usually are increased synchronously.

The increase in the concentration of blood urea without a concomitant increase in the concentration of serum sulphate in our experience has not been indicative of a serious disease of the kidney. However, we do not

wish to postulate on this phenomenon with our present data. We have an impression that a patient who is not dehydrated and who has, let us say, from 80 to 100 milligrams of urea in each 100 cubic centimeters of blood does not have normal kidneys; however, in our experience the injury may not be profound. Adequate treatment may restore a normal renal function but not normal kidneys. Our data seem to indicate that an increased concentration of blood urea and a normal concentration of serum sulphate are related in some way to dehydration.

In brief, we believe that some worthwhile information may be obtained from the determination of the concentration of serum sulphate. For instance, if diuresis reduces an increased concentration of blood urea to normal limits and if the value for serum sulphate remains more than 5 milligrams (1.66 milligrams of sulphur) per 100 cubic centimeters, we believe that the increased concentration of serum sulphate indicates a definite renal insufficiency; whereas, if the concentration of serum sulphate is within normal limits, the value for the blood urea may be disregarded.

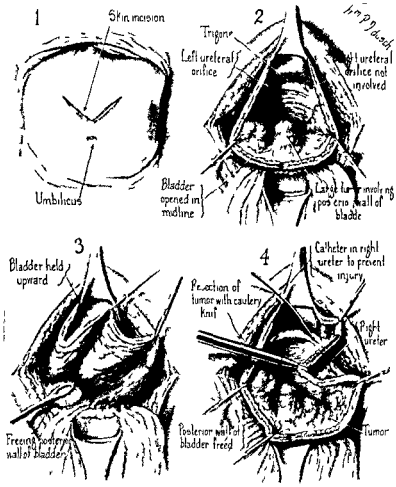


Fig 5 Resection by cauterization 1 Skin incision 2 bladder opened exposing tumor 3 freeing posterior wall of bladder 4 resection of tumor with electrocautery

CLINICAL SURGERY

FROM JAMES BUCHANAN BRADY FOUNDATION, NEW YORK HOSPITAL

THE MANAGEMENT OF BLADDER TUMORS

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THE problem offered by the treatment of tumor of the bladder is not new, but our attempts to solve it have undergone constant change. It is a problem in which every member of the medical profession should take an active interest—whether he be specializing urologist or family doctor. Statistics show that 2 per cent of all tumors are located in the bladder. It is, therefore, a relatively frequent lesion, and one likely to be encountered by anyone engaged in the practice of medicine.

Though this tumor was recognized very early in the history of medicine, modern treatment did not really begin until the year 1910, when Edwin Beer of New York introduced his method of fulguration. Beer's discovery may be said to have revolutionized our whole conception of vesical growths, as well as our methods of dealing with them. Once Beer had led the way, the application of the high frequency current, and the invention of instruments combining cystoscopic and cautery features went rapidly forward, so that we now have at our command three different agents which may be used separately or in combination. These are: (1) surgery, (2) diathermy, (3) irradiation.

They may be employed according to the attending physician's personal judgment, as influenced by his experience and inclination, taking into consideration the location of the growth, its histological structure and stage of advancement. Especially important is the histological structure because of its bearing upon the radiosensitivity of the tumor.

The therapist charged with the treatment of a vesical growth will find plenty of help at hand, but it will often be difficult for him to select the particular method suited to the needs of his individual case. There will be but little trouble in doing this if the diagnosis of either benign or malignant neoplasm can be clearly established. It is with the atypical, border line case that he is likely to come to grief. Therefore, he should always avail himself of every modern means of

diagnosis and correlate the findings of all methods available, namely, cystoscopy, biopsy, and cystography for it is only in this way that he can correctly evaluate the diagnosis.

The ordinary cystoscopic examination is often misleading. Though the foroblique lens system helps to show the tumor in its actual proportions and in proper relation to surrounding structures, no urologist should consider himself properly equipped unless he can also command a retrograde lens system as well as a right-angle lens system, enabling him to view the tumor in all aspects.

X-ray examination of the bladder filled with an opaque medium often gives us much valuable information, for cystography frequently fills in the gaps in the evidence presented by other maneuvers, and enhances their value. At the Brady Foundation of the New York Hospital both umbrathor and diadras are used for this work. Irregularities in the outline of the bladder shadow may serve to locate a growth with accuracy, and though this method used alone might not be of great assistance, in conjunction with other diagnostic means, its importance is much enhanced.

Biopsy is, of course, the criterion by which all other means must be judged. In order to be sure of satisfactory specimens, I have designed a biopsy rongeur which has proved handy and efficient for this purpose. Malignancy often does not appear in a single specimen, if it be taken from one of the tendrils of a bladder tumor, with no part of the tumor-base included. Therefore, the specimen secured must be sizable enough to permit inclusion of "samples" of all constituent cell structures.

In our work at the Brady Foundation for Urology we do not adhere rigidly to any particular "grading" system. Neither do we regularly make use of any of the elaborate systems of classification which have been from time to time put forward for the purpose of differentiation of the intermediate grades intervening between the unquestionably benign and the frankly malignant

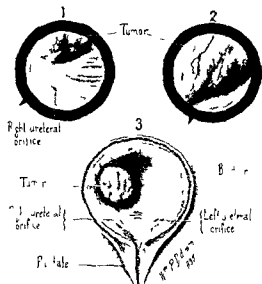


Fig. 1. Clamp method. Typical tumor of the bladder suited for excision by this method showing the common position of such a tumor and its most usual dimension. 1 and 2. Tumor as seen through cystoscope. 3. reconstruction of cystoscopic findings showing position of tumor and approximate size.

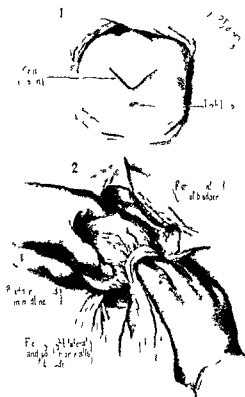


Fig. 2. Clamp method. Skin incision and the method of freeing the bladder's right lateral wall after it has been opened at the midline.

cell types. More and more we incline to the belief that all bladder tumors are potentially malignant and whatever treatment be elected we must bear in mind the necessity of providing against such future dangers.

The cystoscopist should familiarize himself with the fine differences in the aspect of the varied neoplasms which may possibly arise in the bladder. This can be attained only by constant practice and wide experience but from the outset it should be the aim of all who attempt the treatment of bladder tumors. The surgeon cannot be expected to be also an expert pathologist but he must keep in touch with all advances in the study of neoplastic diseases and be ready at all times to give the specializing pathologist enthusiastic and intelligent support.

When the report from the pathological laboratory is received it should be most carefully considered. Its findings must be compared with those obtained by rectal palpation with the results of cystographic observation and the checkings of cystoscopic study. When all these have been evaluated—separately and in their relations one to another—we should find ourselves in a position to take up consideration of the various possible methods of treatment, so that the procedure best

suited to the needs of the particular case in hand may be unerringly selected.

TREATMENT

We have seen that there are now available for the management of bladder tumors three distinct types of treatment which have been employed—separately or in combination—by the most experienced surgeons in this country and abroad. Considering these somewhat in detail we find:

Surgery. It has been statistically established that the majority of bladder tumors are inoperable from the outset because they are so located as to be inaccessible to surgery. Tumors arising on the lateral walls usually involve one or both ureteral orifices. Lateral wall growths comprise 41.89 per cent and trigone and bladder neck tumors 34.41 per cent of the 854 vesical growths classified in the Registry of the American Urological Association. The Carcinoma Registry Committee points out that this fact has an important bearing on treat-

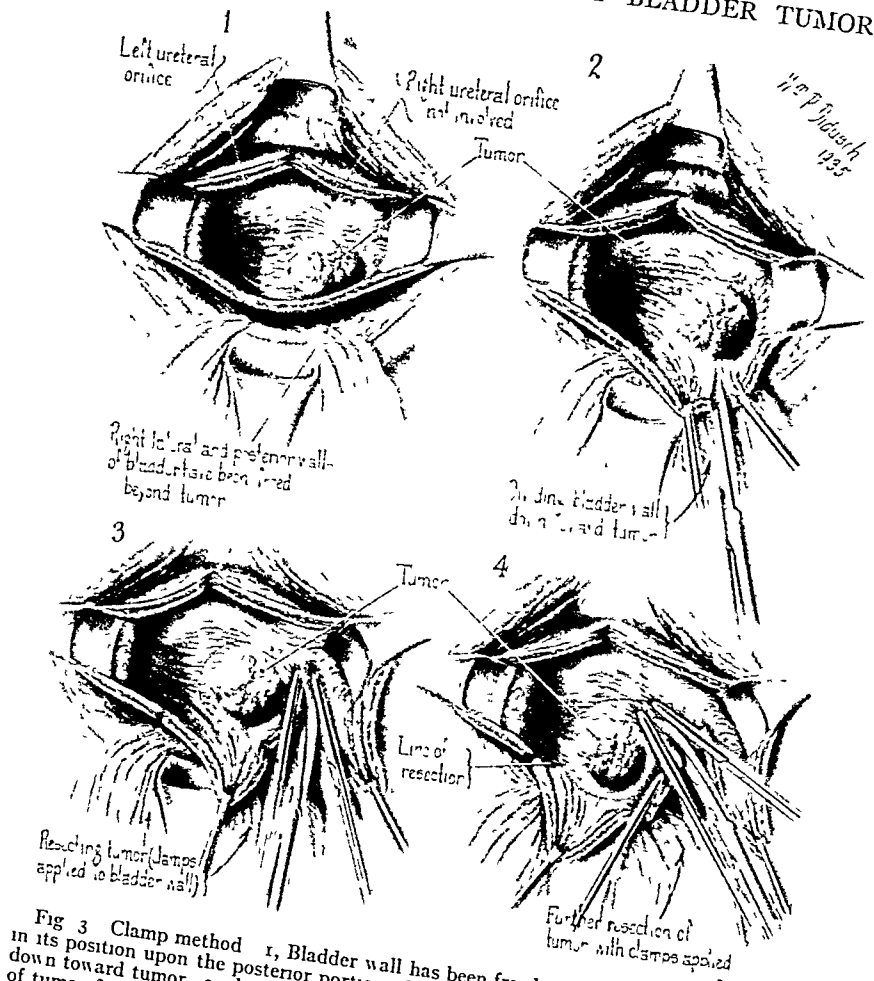


Fig 3 Clamp method 1, Bladder wall has been freed, and the tumor is exposed in its position upon the posterior portion of the right wall, 2, dividing bladder wall down toward tumor, 3, clamps applied to wall, resection begun, 4, further resection of tumor first applying clamps

ment From the surgical standpoint only 23.4 per cent of these tumors can be excised without interference with urethra or ureters. This means that almost invariably requires transplantation of one or both ureters, while those involving the trigone are surgically inapproachable except by using total cystectomy and bilateral ureteral transplantation. The report concludes "It would appear, therefore, that any method of treatment to become generally acceptable must take into account the high percentage of bladder tumors in these areas, and the hazards of a purely surgical approach."

Some of our ablest surgeons, have recently expressed themselves favorably toward total cyst-

tectomy, but I cannot share this enthusiasm. The indications for cystectomy are very definitely limited. It is applicable only to bladders showing extensive papillomatosis entirely confined to the bladder mucosa, or where one or more larger tumors have infiltrated the bladder wall too widely to permit resection but without extending beyond the bladder mucosa. It is useless to remove the bladder unless the patient can be proved free from metastasis, so a searching x-ray examination of all possible foci of malignancy in lungs, bones, or viscera adjacent to the bladder, is an indispensable preliminary.

As the majority of bladder tumor patients are in the late fifties or sixties, we must also consider their life expectancy. Is it worth while to perform

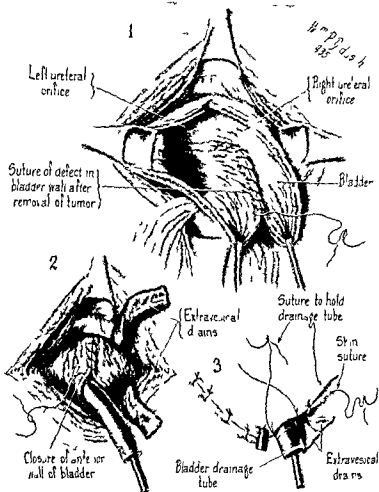


Fig. 4. Clamp method. The closure of the defect in the bladder wall with placing of drains before sewing up the abdominal incision. 1. Suture of defect in bladder wall after removal of tumor. 2. Closure of bladder drains placed. 3. Final skin suture.

so extensive and hazardous an operation as cystectomy upon a person who cannot expect according to unbiased life insurance tables such as those compiled by John Duff for the Metropolitan Life Insurance Company to live more than a few years at best? As many of these people are greatly depleted by concurrent affections of heart, blood vessel and kidneys their life expectation is still more reduced.

Again, removal of the bladder involves implantation of the ureters into the sigmoid or other portion of the lower intestine. Most of the advocates of removing the bladder with the tumor

pass very lightly over this problem of ureters implantation. I spent more than 3 years in investigation and animal experimentation upon this subject performing the operation upon upward of 80 dogs. In practically every instance although many of the dogs recovered promptly from the effects of the operation they later succumbed to kidney infection or other secondary effects and in those which lived long enough to permit their being sacrificed after a definite period hydro-nephrosis and other sequelae of infection and resulting urinary obstruction were in evidence. This was frequently seen in animals whose opera-

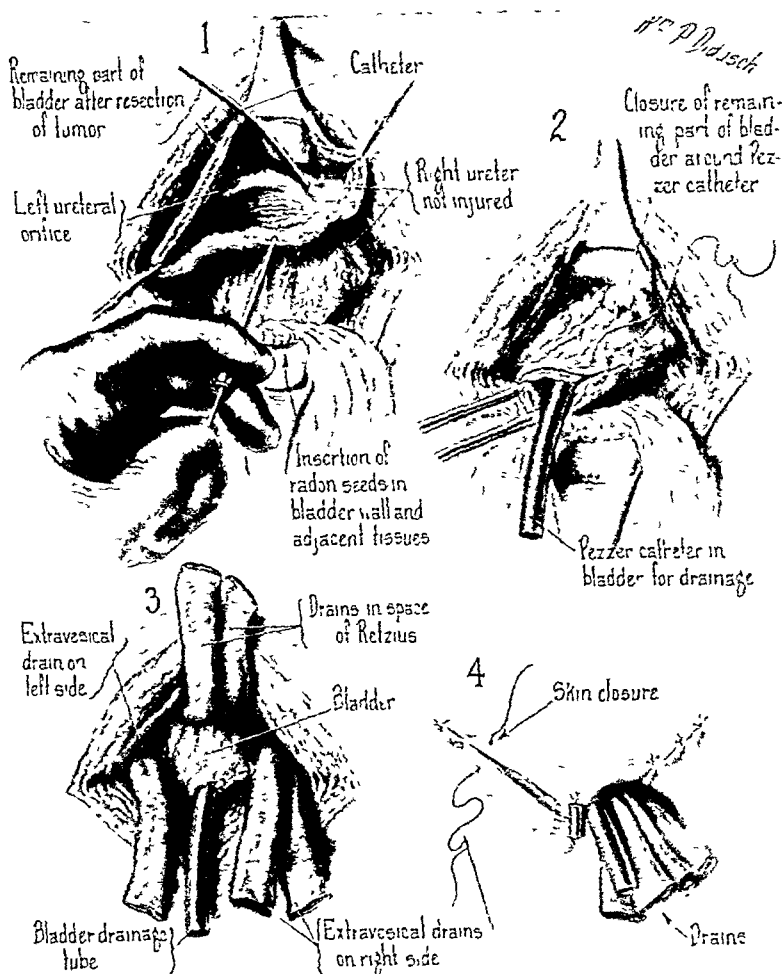


Fig 6 Cautery method 1, Method of "seeding" the cut edges of the remaining portion of the bladder wall before closing it, 2, closure of remaining part of bladder, 3, bladder closed, drains placed, 4, final closing of skin incision

tive wounds were entirely healed so that surgically speaking the operation was a "perfect success." I became convinced that the difficulty lay in the injury sustained by the nerves of the ureteral walls when the ureters were severed from the bladder. The ganglion cells of these nerves apparently play the same rôle in peristalsis as do those of the Auerbach-Meissner plexus in the intestine. When their dendrites are cut, peristaltic waves are halted at the site of injury, even if no actual stricture has been formed. This fact was demonstrated by Alksne and by Gouverneur 25 years before I made my experiments and was observed in a human in whom the ureter had been

cut by accident and had been sutured together when no infection was present. A dilated ureter and hydronephrosis were the result in each case.

In my opinion any operation involving ureteral implantation is not justified upon an elderly or enfeebled patient. If stricture of the ureter occurs at its place of implantation in the intestine, ureteral obstruction will be followed by hydronephrosis or pyonephrosis, with ultimate uremia and death. If actual stricture should not occur, peristalsis will be lessened or altogether inhibited, urine will collect behind the break in the continuity of the ureteral wall, and though it will

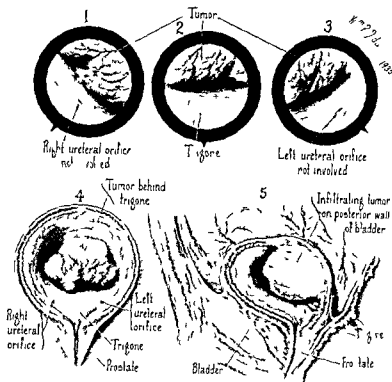


Fig 7 Loop ball disc method 1 & 3 Cystoscopic views of a large tumor behind the trigone infiltrating the posterior wall of the bladder 4 reconstruction of condition 5 sagittal section showing position of tumor

soon 'spill over' and partially empty itself by gravity eventual hydro ureter is inevitable. An operation presenting such grave hazards should in my opinion, be employed only in the rarest instances.

Diathermy Since its introduction by Beer in 1910 diathermy or fulguration has been the surgeon's mainstay, in the destruction of benign vesical tumors. For malignant growths it has never been satisfactory as its originator freely admits. Excision by the cauterizing knife followed by irradiation, which may be looked upon as a "diathermic method" has been more successful but recurrence too often follows the use of diathermy alone to make it seem desirable to the majority of operators.

Irradiation While the use of radium and roentgen ray therapy has proved a valuable adjunct to other methods employed in combatting bladder tumors radiation therapy alone has not been satisfactory. This is admitted by practically all therapists.

DESCRIPTION OF MODERN METHODS

After long experience with the various methods just outlined a technique has been worked out which is now proving efficient in the majority of cases. For the minority to which this more or less standardized technique is not applicable variations are necessary but these too have become quite well standardized and their indications clearly established. They may be listed as follows:

Method I Resection using clamps excision by scalpel followed by deep x ray therapy.

Method II Resection by cauterizing knife with radon implantation before wound is closed.

Method III Fulguration by loop and disc electrodes through a suprapubic incision followed by implantation of radon seeds.

Method IV Closed method removal of exuberant portion of growth by the resectoscope followed by intra urethral implantation of radon seeds and in some cases external x ray therapy.

Incisions There are many types of incisions for approaching the bladder. The author usually

uses the midline incision. The director of the Brady Foundation of the New York Hospital, Lowsley, prefers the inverted "V" in most cases feeling it gives him an opportunity to make a wider resection of the bladder if necessary, by the cutting of the recti muscles. There are urological surgeons who prefer the Pfannenstiel incision. These are all personal equations that the surgeon must solve himself and have very little bearing on the actual resection of the bladder tumor itself.

Clamp method. In Figure 1 is shown a typical tumor of the bladder suited for excision by the clamp method, showing the common position of such a tumor and its most usual dimensions. In Figure 2 is shown the skin incision and the method of freeing the right lateral wall of the bladder after it has been opened at the midline. In Figure 3 the bladder wall has been freed, and the tumor is exposed in its position upon the posterior portion of the right wall. The bladder wall is divided downward toward the tumor, the clamps being applied to the wall as resection begins. Figure 4 shows closure of the defect in the bladder wall, with placing of drains before sewing up the abdominal incision. The value of this procedure is enhanced by irradiation after resection is completed, as we thus take care of any possible extension of the malignant process which may have remained outside the line of resection.

Cautery method. Figure 5 (frontispiece) shows resection by cautery—skin incision, opening of bladder wall and removal of large tumor at base of bladder. In Figure 6 we have illustrated, 1, the method of "seeding" the cut edges of the remaining portion of the bladder wall before closing it, 2, closing of the wall about a Pezzer catheter, 3, placing the drains, and 4, final closing of the skin incision. This method may be employed when for any reason loop and disc electrodes are not available.

The technique next to be described is considered preferable by the author whenever possible.

Loop-ball-disc method. For large tumors, impossible to remove by the intra-urethral route, excision with the loop electrode through a midline incision has proved most satisfactory to me. In Figure 7, 1, 2 and 3, are shown cystoscopic views of a large tumor behind the trigone, infiltrating the posterior wall of the bladder. Figure 8 shows details of the three different electrodes employed in carrying out the technique. In Figure 9, 1, the ball electrode is applied to the wall encircling the tumor. In Figure 9, 2, the entire tumor mass is being removed with the loop electrode while Figure 9, 3, depicts the method of applying the disc electrode to the base of the tumor after the

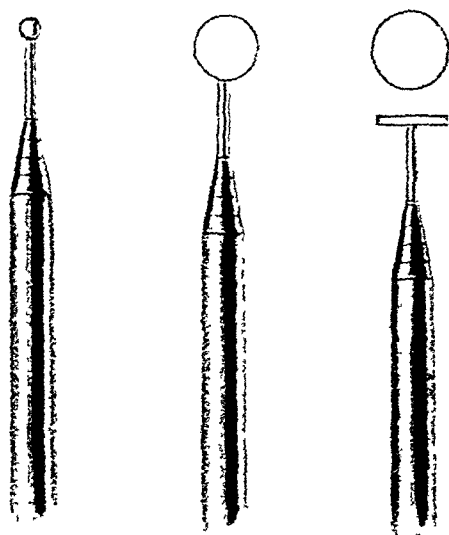


Fig 8 Details of three different electrodes employed in carrying out the technique

exuberant portion has been excised, to control any hemorrhage that may be present. When the entire site has been thoroughly cauterized, radon seeds are implanted, as demonstrated in Figure 9, 4, so as to take care of any infiltration which may have taken place in the muscular wall of the bladder.

Combination closed method. Except when a tumor is too large to be handled by intra-urethral methods, or the conditions under which operation must be performed will not permit the use of the necessary instruments, the following technique will be found by all means the most satisfactory for the ordinary bladder neoplasm. In essence, it is the same as method III just described, although it is performed intra-urethrally instead of through a suprapubic opening.

The size of the tumor is first ascertained. For this purpose I have designed with the assistance of Mr F. C. Wappler, an instrument which facilitates both inspection and measurement, permitting correct estimation of the amount of radon dosage required to irradiate the base after the mass of overgrowth has been removed by loop electrode of the McCarthy or Kirwin resectoscope. When the measurements have been taken the instrument is withdrawn, the resectoscope is substituted, and the growth is cut away with the loop, as shown in the drawing of the suprapubic method, Figure 9, 2.

When the growth has been cut away and the site cauterized by the resectoscope, radon seeds

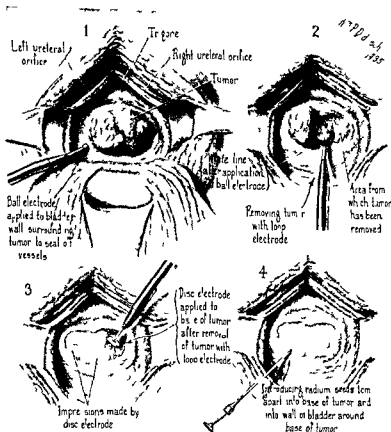


Fig 9 1 Ball electrode is applied to wall encircling the tumor 2 entire tumor mass is being removed with loop electrode 3 method of applying the disc electrode to the base of the tumor after the exuberant portion has been excised 4 implantation of radon seeds

are at once implanted in the affected area the introducer designed by the author being used. This introducer can be inserted through the measuring arm of the first instrument if it is found desirable.

The Kurwin resectoscope is particularly well adapted for removing the exuberant portions of the tumor because its electrode rotates behind a fenestra and is thus much less likely to cut through the bladder wall, even when it has been weakened and thinned by malignant infiltration. When a special instrument is not at hand ordinary fulguration may be used to remove the visible tumor mass. The important feature is the scraping away of all the projecting mass so that the base may be fully exposed for radon implantation. Application of the disc electrode will then leave a clear surface ready to receive as many

radon seeds as the measuring instrument has indicated to be necessary.¹

This operation by the closed route minimizes shock, produces little or no hemorrhage and can be borne by even a greatly enfeebled patient better than an open operation in which a spinal or general anesthesia would be hazardous. I believe it should be used in preference to any other except in cases of very large tumors when intra-urethral methods are technically impossible. It is only under unusual circumstances that the surgeon will be so situated that he cannot employ one of the combination procedures. However should this situation arise I believe the loop ball disc method is preferable if owing to the size of the tumor a cystotomy is necessary.

¹ For a more detailed description of this instrument mentioned see J. Urol. 1937 38: 2.

CONCLUSIONS

The treatment of bladder tumors still offers many difficulties to the surgeon, despite great advances in pathological study and the design of instruments providing means of intervention which were impossible a few years ago.

Effort has been made to demonstrate that adherence to any one technique in dealing with vesical tumors whenever and wherever found, is a fundamentally unsound practice. No one method can be adapted to all cases.

Radical surgery is still widely practiced by eminent members of the urological profession. Extensive series of cases of total cystectomy have been reported for which considerable success has been claimed. The author regards any operation involving ureteral implantation as unjustified for use upon elderly and enfeebled subjects such as the majority of bladder tumor patients, and at best as a hazardous procedure with a highly uncertain outcome.

The principal methods of treating tumors of the bladder are offered together with a technique which will fulfill the requirements of conservative practice in the great majority of instances. It is recommended as combining the excellencies of all three standard methods, while eliminating the drawbacks to which each is subject when used alone.

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SURGICAL FUSION OF THE WRIST JOINT

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SURGICAL fusion of the wrist joint for deformities and disease is relatively new. Very little is presented in the literature concerning the subject. No conditions other than tuberculosis poliomyelitis, paralysis of the radial nerve in war fracture of the humerus affection of the wrist joint in syringomyelia, and brachial plexus paralysis have been given as the etiological indications for such operations. Except for tuberculosis no author has presented more than 1 case, and in none of the cases is there a detailed report of the follow up and end result. Ely offered a fusion operation for tuberculosis of the wrist in 1920 and presented 2 cases. Blanco in 1933 published 16 cases after the method of Ely.

This paper is a presentation of 44 consecutive and unselected cases in which fusion of the wrist has been performed for 8 different conditions, namely tuberculosis rheumatoid arthritis obstetrical paralysis, poliomyelitis fracture dislocation, Volkmann's paralysis gonorrheal arthritis and spastic paralysis. The average follow up is 4 1/2 years, and the end results are given in detail.

TUBERCULOSIS

History. The treatment of tuberculosis of the wrist until recent years has been highly unsuccessful. Long ago it was realized that operative treatment was indicated. In fact it has been nearly a hundred years (1839) since Dietz performed the first resection for caries of the wrist joint, and since Dupuytren (1846) wrote it is the slow insidious inflammation of the wrist terminating in the white swelling for which we are so often obliged to have recourse to amputation.

Though resection had its adherents it came more and more into disrepute because it left the hand useless and because excision often was repeated and repeated until pyogenic infection developed, making amputation necessary if the life of the patient was to be saved. Therefore attempts to preserve function of the extremity while curing the disease were inevitable. Fifty years later in 1881 Macnamara suggested ankylosing the involved joint when he said, if we

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can secure ankylosis without excision, the patient will, as a rule have a much better hand than he is likely to gain after the resection of the bones.

Furthermore, he did not approve of resection for those cases too far advanced for ankylosis and added "If the condition of the patient and the limb is such as to preclude all hope of recovery I should advise amputation rather than resection of the joint and in truth, in several cases of resection of the wrist joint the patient would have been better off with an artificial hand than with the mutilated remains of the one left after the operation (resection)."

Coote in 1867 considered that the maintenance of bodily strength and complete rest for many months or even years, was the treatment of choice. He believed further that, 'No operation can be of any avail,' although he stated that in very severe cases in adults amputation might be necessary.

Injection of iodoform emulsion into each bone and joint at the wrist was described by Senn in 1892 with the admission that the functional results were better than those obtained by resection 'in case the treatment proves successful'.

More accurate descriptions of the disease began to appear around 1900 but it was not until 1910 that Ely offered an operation for fusion of the wrist. By this method a tibial graft is placed between the base of the third metacarpal bone and distal end of the radius. Other types of bone grafts have been suggested also and today fusion is considered to be the treatment of choice, although as late as 1930 Whitman recommended splints and in severe cases early excision of the wrist with amputation as a final resort.

The first wrist fusion performed at the New York Orthopaedic Dispensary and Hospital was by Dr Russell A. Hibbs on April 23, 1919 (case No 27362). Up to July 1935 23 patients were operated upon for tuberculosis of the wrist at this hospital. Twelve of these were females and 11 were males. The disease affected the right wrist 11 times and the left wrist 12 times.

Quite surprising was the fact that in 6 of these 23 patients the disease spread from a primary lesion in the wrist joint to involve the ulnar epiphysis later and conversely in 1 case tuberculosis spread from the primary focus in the ulnar epiphysis to involve the wrist joint. This



Fig 1

Fig 1 Tuberculosis of wrist of many years' duration without operative treatment Anteroposterior and lateral views Note in both roentgenograms that the ulnar epiphysis is not involved



Fig 2

Fig 2 Same case as in Figure 1, 1 year 9 months later Anteroposterior and lateral views Compare with Figure 1 and note in both views that disease has spread and that ulnar epiphysis now is involved



finding seemed most unusual to me because the distal end of the ulna is blocked from the wrist joint by the interarticular fibrocartilage. Therefore, I undertook special work to try to determine the reason for the spread of the disease in this particular area

A THEORY AS TO THE ETIOLOGY OF SECONDARY TUBERCULOUS INVOLVEMENT OF THE ULNAR EPIPHYSIS FOLLOWING A PRIMARY TUBERCULOUS FOCUS IN THE WRIST JOINT

The ulnar epiphysis is not a part of the wrist joint. It is prevented from so being by the interposition of the triangular interarticular fibrocartilage which separates the distal end of the ulna from the lunate and triquetral bones.

In this series of 23 cases, secondary involvement of the ulnar epiphysis, or of the wrist joint, occurred 7 times, or in 30.4 per cent of the patients.

In 6 of these 7 cases, the wrist joint was involved primarily with the disease spreading to the ulnar epiphysis later (Figs 1 and 2). These 6 cases had no symptoms or roentgenographic findings referable to the distal end of the ulna for an average of 18.6 months after the condition present in the radiocarpal joint had been diagnosed as tuberculous.

In the 1 remaining case, the disease spread from the ulnar epiphysis to the wrist joint (Fig. 3). In this instance it is not known how long after symptoms developed in the distal end of the ulna that the radiocarpal joint became involved, but the roentgenograms revealed a large cavity in the ulnar epiphysis while only slight decalcification was present at the triquetral and pisiform bones, and it was much later before destruction occurred at the distal end of the radius. This indicates that the process was of much longer duration in the ulna than in the radius.

It is well known that the articular fibrocartilage excludes the ulna from the wrist joint. It is likewise well known that cartilage is one of the most resistant of tissues to tuberculosis. To try to explain, therefore, the extension of disease from one joint to the other, particularly from the radiocarpal joint to the distal end of the ulna, cadaver dissection was undertaken by the author at Columbia University College of Physicians and Surgeons. Eighty unselected cadavers laid out for anatomical study over a period of 2 years were used and 160 wrists were examined personally. The triangular interarticular fibrocartilage of each wrist was studied carefully. Seventy-four of these were normal, the central portion of the disk being about 3 to 5 millimeters in thickness. Thirty-seven



Fig 3 Tuberculosis of ulnar epiphysis. Anteroposterior views. On the left note large radiolucent area at distal end of ulna and only slight involvement of triquetrum and pisiform bones of wrist. On the right is same case 1 year 1 month later. Note that disease has spread and now has destroyed the wrist joint.

presented only a very thin membrane covering the center of the disk. These membranes were of the thickness of tissue paper and were as easily ruptured. Forty nine, or 30.6 per cent, were definitely perforated the perforation varying in size from 1 to 14 millimeters (Fig 4). The perforation was bilateral in all cadavers except 5 but the 5 disks on the opposite side that were not perforated were extremely thin.

A few books on anatomy do not mention that the articular disk at the wrist may be perforated (Spalteholz 7th edition in English). The latest editions of five standard textbooks on anatomy merely mention the perforation by saying "It (the disk) is in some cases perforated" (Piersol 1930) "the articular cavity (of the wrist joint) is sometimes continuous with that of the distal radioulnar joint" (Morris 1933) "There is no communication between the radio-ulnar joint above and the radiocarpal joint below except when, as occasionally happens, the triangular cartilage has a perforation" (Davis, 1934) "(the disk) is occasionally perforated" (Gray, 1936) and "in some cases the disc is perforated" (Cunningham, 1937). Because the incidence is not given there are no data available with which the findings in this study may be compared.

Upon the figures here obtained it appears that there is a definite relationship between 30.6 per cent of perforations of the articular disk at the wrist and 30.4 per cent of secondary ulnar or wrist involvement when tuberculosis affects pri-

TABLE I—AGE AS TO YEARS

Age—years	Cases
20 to 30	9
31 to 40	5
41 to 50	2
51 to 60	3
61 to 70	1

marily either of the joints. The presence of the opening in the disk destroys the barrier that normally exists between the ulna and wrist. It may be possible, but the above percentages do not substantiate it for the thin membrane across the disk to be ruptured by swelling and pus under pressure.

It seems plausible, therefore to assume that when disease of the distal end of the ulna follows disease of the wrist joint or occasionally vice versa, it is due to a developmental perforation of the triangular interarticular fibrocartilage.

Age. Most authors state that tuberculous disease of the wrist is rare in youth. In this series 3 patients, or 13 per cent of the group, were not over 16 years of age. The ages were 5, 7 and 16.

The 5 year old girl was brought here from an asylum and the duration of symptoms was unknown. She was kept at the country branch of this hospital for 1 year and fusion was performed at the age of 6. She was discharged against advice 4 months later and taken to Italy. The end result remains unknown.

The 7 year old boy had had symptoms for 1 year. Fusion was done 1 month after tonsillectomy had been performed. Refusion was necessary 9 months later and 1 year from the last operation the patient had a solid fusion and was symptom free (Figs. 5 and 6).

The 16 year old girl had had symptoms for 2 months. Fusion was done at once and 9 months later the wrist was solid and the patient was cured.

The number of patients in the other age groups is shown in Table I.

This table indicates that tuberculosis of the wrist is most common during the 2 decades of 20 to 40 years and that it is not unknown in youth or in old age.

Familial history. History of tuberculosis in other members of the family was not conclusive since in 9 of the cases it was not recorded. Eleven patients however denied the presence of familial tuberculosis while there was a positive history in 3 cases.

Previous treatment. The average period of time before proper treatment was instituted for these patients was 4.6 years. In all but 2 cases the previous treatment involved procedures that should have been avoided such as heat, massage, incision of swellings, diathermy, wet dressings and baking. It would have been much better to have given no treatment at all than to have employed such harmful procedures. Stress, therefore should

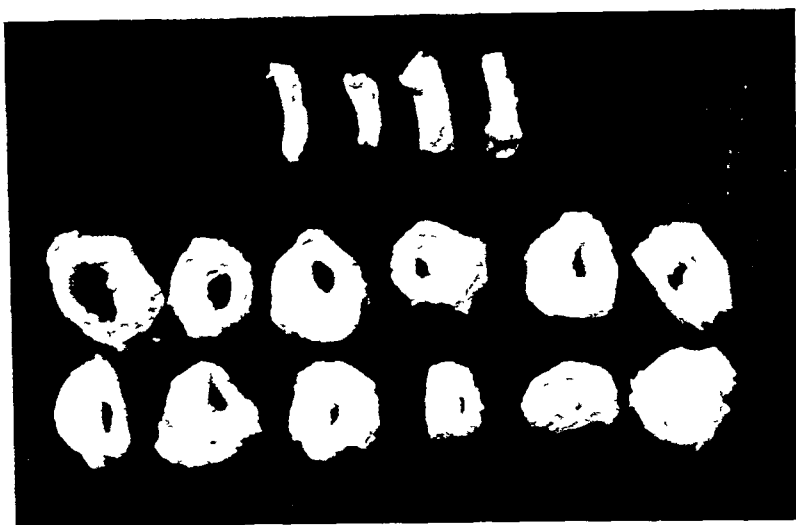


Fig 4 Interarticular fibrocartilages showing variation in thickness of disks and in size of perforations Top and bottom rows have normal disk on the right for comparison

be laid upon early and accurate diagnosis through aspiration and guinea pig examination so that loss of valuable time and improper treatment may be avoided.

Symptoms. Duration of symptoms varied greatly. The shortest period was 2 months and the longest was 28 years. The onset of symptoms was slow or sudden. Six of the patients had previous tuberculous foci elsewhere in the form of pulmonary, lymph node, fallopian tube, or tendon sheath involvement. Nine attributed the onset to injury. Long hours, hard labor, damp surroundings, and night work, were given by others as the cause of a generalized run-down condition which was present prior to the onset of symptoms. In some patients the original pain was first felt in the index finger, in others in the third and fifth fingers. Stiffness of the fingers was followed by intermittent aching which often increased until the patient was awakened at night by pain. The swelling, pain, and stiffness of the wrist and fingers, slowly but steadily increased until the patient gave up work and finally consulted a physician.

Physical examination. Typical physical findings are those of a swollen wrist joint, held in a protective manner, generally in the position of slight flexion and pronation. Motion is slight and all attempts to move even the fingers are limited by marked pain and spasm. Grip and active muscle power are poor. Localized heat and redness may be present at times to a slight degree but generally are absent. Tenderness about the wrist is exquis-

site. Fluctuation over the ulnar head may occur if the ulnar epiphysis is involved. Bogginess often is present. In contrast to the periarticular swelling is the marked degree of atrophy of the forearm, sometimes measuring 2 inches in comparison with the normal side. Sinus formation is not as frequent as one would think and, before operation, is rare. When the tendon sheaths are involved, fusiform swellings and soft tumors occur about the wrist and hand.

Roentgenographic examination. Roentgenograms early in the disease (Fig 5) reveal smoky decalcification with marked swelling. The cartilage space at the radius is thin. There is no bony productive reaction. Late roentgenograms (Fig 7) show radiolucent areas, erosion of articular surfaces; effusion, often marked and sharply outlined, decalcification, and thin cartilage spaces. Sequestra at times are present.

Procedures preliminary to fusion. Several procedures should be carried out preliminary to fusion of the wrist. Tonsils should be examined and removed if necessary, particularly in children. Duncan states that tonsils were removed from 100 patients with joint tuberculosis and upon microscopic section were found to be tuberculous in 24 cases. Since pulmonary tuberculosis is so often associated with tuberculous wrists, roentgenographic examination of the chest should be made. In this series, roentgenograms were available in 13 cases and of these, 4 were positive before operation for active pulmonary tuberculosis. None that was negative before operation became posi-

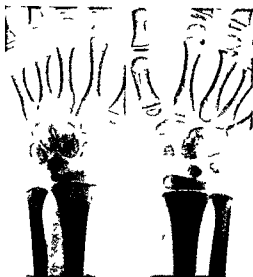


Fig 5



Fig 6

Fig 5 Tuberculosis of wrist in child aged 7 years Anteroposterior view of diseased wrist on left compared to normal before operation A roentgenographic example of tuberculosis early in the disease

Fig 6 Same case as in Figure 5 1 year after resection Anteroposterior and lateral views Note ulnar deviation of 20 degrees the third metacarpal being off center and not in straight line with forearm

tive after operation The history and physical examination should be used as further checks upon other tuberculous foci Frozen section examination should be performed in every case at the time of operation and no fusion should be carried out in the presence of a negative report except when the joint is so disorganized that fusion is the procedure of choice, irrespective of diagnosis Upon a negative report with the joint not appearing too diseased and without destruction of cartilage, closure of the wound should be made If the permanent sections or guinea pig inoculation show tuberculosis fusion of the wrist should be performed at a second operation

Tourniquet technique The operative procedure is made easier by the use of a tourniquet This should be applied after all blood has been evacuated from the extremity by carefully carrying an Esmarch bandage up the arm from the finger tips The constricting portion of the tourniquet should be broader than that used upon the lower extremity because the upper extremity presents more superficial nerves and less subcutaneous fat It should be a pneumatic cuff that will not leak because a leaking tourniquet allowing venous stasis is more apt to produce paralysis than a tight tourniquet producing pressure on the nerves In this series, tourniquets were used on all the patients and no paralysis occurred although the

operating time alone varied from a minimum of 47 minutes to a maximum of 1 hour and 37 minutes

Fusion technique Many factors enter into obtaining a solid fusion of the wrist and they are discussed in various parts of this paper Here I wish to mention the difference between small bone chips and large bone grafts in regard to fusion

During the period the bony mass is becoming vital irrespective of whether the mass consists of many small chips or a single large graft, absorption progresses, the mass remains discreet and fractures occur easily Union of the mass takes place quite early in comparison to complete revitalization In the case of bone grafts it takes a great length of time for the transplanted bone to change from an inert state to a vital state This period of time depends upon the cross sectional size of the graft In the case of small chips it takes a much shorter period of time for the bone to change to a vital state because the surface area of the chips is much greater and the cross sectional size of the chips is much smaller The expected time for extensive revitalization to occur when small chips are used is several months while in the large grafts a comparable state does not develop in less than several years

Since it is desirable to obtain revitalization as quickly as possible in order to arrive at a state of

safety (Fig. 7) where the danger of absorption and fracture of the fusion area is eliminated, small bone chips are considered better than large bone grafts

The bone chips are obtained, as the occasion demands, from various parts of the skeleton but usually from the distal third of the radius, which may be exposed through the same incision. Further, the cartilage of each carpal bone to be fused is removed, and portions of these bones are broken down into chips. When these sources are not sufficient, the ilium or the tibia is used. All chips are made quite small, generally about 12 by 3 millimeters. In a few of the earlier cases large bone slabs and grafts, ranging in size from $1\frac{1}{4}$ by $\frac{3}{4}$ inches to $2\frac{1}{2}$ by $\frac{1}{4}$ inches, were placed across the radius and denuded carpal bones. Union in these cases was slower, the average time being 8 months, while in those cases in which small chips were used, the average time was only 6 months.

Operative technique. The skin incision is made dorsally between the extensor pollicis longus and extensor indicis proprius. The incision is a longitudinal one and need not be longer, generally, than 8 centimeters. The subcutaneous tissues and dorsal carpal ligament are incised. The extensor pollicis longus and extensor carpi radialis brevis are retracted radialward while the extensor indicis proprius and extensor digitorum communis are retracted ulnarward. The capsule is opened and the radiocarpal joint exposed.

From this point on the operation depends upon the pathological findings. Generally, only those joints involved are fused although the better functional and cosmetic results in this group were those in which the radius, both rows of carpal bones, and all the metacarpal bones, except the first, were solidly fused. The latter is considered the better procedure.

The distal epiphysis joins the diaphysis of the radius at about the twentieth year. In patients younger than 20, care is taken not to injure the epiphyseal cartilage. However, when the area has been partially destroyed by disease, the remaining portion may be excised to prevent unequal growth, and fusion is carried out as described.

When diseased, the distal end of the ulna is resected. This often gives an unsightly defect, as if the hand were displaced medially, and slight medial motion, in spite of the radius being fused, may be the result. However, fusion of the ulna to the carpus should not be attempted because it would not only be difficult to perform, but also would prevent the movements of pronation and supination and thus produce an incapacitating deformity.



Fig 7 Tuberculosis of wrist. Anteroposterior views before and after operation. The left is a roentgenographic example of tuberculosis late in the disease. The right is same case 1 year 6 months after fusion with fracture of radius and ulna demonstrating strength of fusion area.

It is not considered necessary to remove all the diseased tissue and, in fact, such is impossible at the wrist. However, it is necessary that all cartilage be removed from the joints to be fused, except on the anterior aspect. Often destruction may be so great as to require the complete removal of a bone. Unless diseased, and none was in this group, particular care is taken not to enter the first carpometacarpal joint because complete motion of the thumb is extremely important to the patient. If disease should be present at this joint, resection would be preferable to fusion because of the importance of thumb motion.

An adequate number of bone chips, which means a large amount, are placed in all the spaces where bone destruction has occurred, as well as between the various bones to be fused, and particularly over the dorsum of the radionavicular joint.

Closure is by interrupted sutures throughout because of the danger of the wound breaking down. It is felt, also, that although proper closure will not obviate all sinuses it will materially affect their incidence. Every attempt is made, as difficult as it may be, to close the capsule as far as possible. This aids in preventing adhesions about the tendons as well as leakage from the joint. The dorsal carpal ligament is carefully united. The subcutaneous tissues are closed with interrupted plain catgut sutures and the skin edges with interrupted silk sutures.

Plaster technique. Many casts following fusion are applied no higher than the proximal forearm. This is believed to be wrong because it violates



Fig 8

Fig 8 Tuberculosis of wrist. Wrist in plaster after operation showing in anteroposterior view proper neutral lateral position with third metacarpal in line with forearm and in lateral roentgenograms proper degree of extension (30 degrees)



Fig 9

Fig 9 Same case as in Figure 8 2 years 6 months after operation showing solid fusion Anteroposterior and lateral views Compare with Figure 8 and note that neutral lateral position has been maintained but that proper degree of extension has been lost

the rule of immobilizing one joint above and one joint below the area involved, because the principal area to be fused in a wrist fusion is the radio-navicular joint and a cast that does not immobilize the elbow and thereby eliminate rotation of the radius cannot completely immobilize the radio-navicular joint, and because a cast extending above the elbow allows much more comfort to the patient immediately after operation which fact may be observed at the bedside. In this series the data were not sufficient to offer definite proof that casts applied no higher than the proximal forearm cause failure of fusion but it is felt that the presence of rotation mobility is a factor in some cases of pseudarthrosis.

In addition to extending above the elbow, the cast should always extend to the finger tips. This is also more comfortable for the patient because the hand is better immobilized. If contracture deformity of the fingers is present and often it is, the fingers should be held extended 45 degrees in order to stretch the flexor muscles. When the thumb presents no deformity it should be left out of plaster, and because there is a great tendency for pressure to occur at the base of the thumb the cast should be cut well back of the first carpo-

metacarpal joint rather than just down to the metacarpophalangeal joint, as so frequently happens.

Another point I wish to emphasize is the promiscuous changing of casts in order 'to take a look and get an x ray'. To remove a cast and apply another one produces motion, pain and change of position, at the involved joint. The cast should be changed 2 weeks after operation in order to remove the sutures, inspect and dress the wound and overcome the effects of swelling. Then a lighter more snug and comfortable cast is applied and left on an additional 10 weeks. In this group of 23 cases union took place no sooner than 12 weeks and the average period was 24 weeks. Assuming therefore that at least 12 weeks are necessary for fusion to occur, it would seem unnecessary to change casts before that period except during the second postoperative week as stated, unless there is a better excuse than to take a roentgenogram. There are two reasons for this attitude. First as to fusion it is practically impossible no matter how much one tries, to prevent motion at the involved joint which in turn may not only retard but be the cause of failure of fusion. Second, as to mainte-

nance of position. Normally the flexors at the wrist are much stronger than the extensors. Further, often at operation the fingers are in an already contracted state. Therefore, when support is removed there is a great tendency for the wrist to flex. Assuming that the wrist is in proper extension it is quite doubtful that the same amount of extension will be present, due to the factors named, after the cast is changed. (Compare Figure 8 with Figure 9.) In only 2 of the 23 cases presented here was the same amount of extension present when fusion occurred as was present immediately after operation.

Position of function At the beginning of the twentieth century, mention was first made in the literature that the position of hyperextension should be obtained when splints are applied to a tuberculous wrist. Now that fusion is the accepted treatment for tuberculosis of the wrist, it becomes more necessary that attention be paid to the proper postoperative position. A hand hyperflexed or hyperextended has a poor grip. A hand at 180 degrees, i.e., the metacarpal bones in a straight line with the forearm, is not in the proper position for convenience of gripping or for strength of gripping. The ideal position of function, therefore, lies between 25 and 30 degrees' extension (Fig. 8). I like to remember this by the simple procedure of "making a fist." As the fingers are flexed into the palm, the wrist automatically goes into the proper amount of extension to furnish maximum strength, function, and cosmetic appearance.

I would like to add another "position of function" to that of hyperextension as described by Kanavel and others. It seems to me to be very important, yet I can find no description of it in the literature. I refer to "neutral lateral position" of the hand (Figs. 8 and 9). This means that the hand should not be deviated to either the ulnar or the radial side but should be straight forward on the forearm. For some reason most students of surgery believe that all wrists and hands, when immobilized, should be put up in varying amounts of ulnar deviation. It is held by some that such is the normal anatomical position. If one should believe that the latter is true, let one make a grip with the hand held in ulnar deviation and note how weak the first three fingers are. However, if the hand is held loosely and the fingers firmly flexed into the palm, one will find that the hand assumes neither ulnar nor radial deviation but is straight forward on the forearm in neutral lateral position. This position is demonstrated also by "making a fist." Another way to accomplish the position is to flex the middle finger into the palm,

and whenever the hand is straight on the forearm the flexed middle finger will point up the forearm. From the dorsal aspect the hand is in neutral lateral position when the middle finger is in line with the middle of the forearm.

Besides strength, there are other reasons why the hand should be immobilized in neutral lateral position. These are writing, awkwardness, and appearance, and they can be described best by giving actual cases. One patient was a stenographer whose wrist was fused in ulnar deviation. She suffered great fatigue, numbness, and pain along the hypothenar eminence and fifth finger when writing, because her hand was tilted and could not rest smoothly upon the desk. Another patient whose wrist was fused in ulnar deviation was a man who complained of awkwardness in work as well as in the performance of small acts. The hand being off center made it difficult for him to be accurate in picking up small articles and in grasping. As for appearance, a third patient denied symptoms from the ulnar deviation but admitted embarrassment because it was this deformity alone that attracted attention to her wrist. An example of a wrist fused in ulnar deviation is seen in Figure 6.

In summary, there are two factors in position of function of the wrist: (1) 25 to 30 degrees' extension, (2) neutral lateral position.

Gross pathological findings. Operative findings vary greatly and, of course, every tuberculous wrist does not present the same picture. In every case except 7 the disease appeared to have originated at the lower extremity of the radius. In 5 of the 7 cases the disease was diffuse, and its source could not be ascertained. In the sixth case the ulnar head was chiefly involved, presenting a cavity one-fourth inch in diameter filled with caseous material. The seventh case presented a definite cavity in the greater multangular bone while the navicular and radius were negative.

The distal end of the radius at times is intact but generally it presents an abscess cavity of varying size, sufficient often to destroy the entire distal end and extend proximally up the shaft. These cavities contain in some instances as much as 2 ounces of either caseous material, typical tuberculous pus, or yellow pus of varying consistency. When pus is present, it generally is localized to the radionavicular region, but at times it extends between the two rows of bones, even to the capitate and second and third metacarpal bones.

The synovial membrane is pale and gray, occasionally gray-red from inflammation. It is thick, boggy, or edematous, and generally of soft

TABLE II—END RESULTS AS TO CURE FROM SURGICAL FUSION OF THE WRIST FOR TUBERCULOSIS

Result	Cases
Solid fusions following first operation	8
Solid fusions following second operation	3
Solid fusions following third operation	1
Solid fusion with resection of ulnar epiphysis later	1
Refusal to have repair of pseudarthrosis	3
Amputation (1 died of pulmonary tuberculosis)	2
Death (carcinoma and pulmonary tuberculosis)	
Unknown (moved away)	3

or gelatinous consistency. Often the entire carpus is covered with pale, purple gray, tuberculous appearing granulation tissue which at times bulges out upon incision of the capsule.

The cartilage is either eroded, atrophic, thin, friable, or absent. Sometimes it is loose and can be stripped away easily or even picked out with forceps alone. The resistant quality of articular cartilage was again demonstrated in one instance in which the entire proximal row of bones was destroyed but a large cavity in the radius was discovered only after the radial cartilage had been removed. Several cases also revealed cartilage lying free although an entire row of bones was absent. In one case the styloid process of the ulna was separated.

The involved joints are always thin and narrow and very little passive motion can be elicited, particularly when disease is present throughout the carpus. The bones are very soft, decalcified and atrophic often being one half normal size distorted and misshapen. When deep cavities or extreme decalcification are present the bones may be macerated or mashed together after removal of the cartilage. Sequestra occasionally are present. The proximal row of bones is generally diseased and at times entirely destroyed except for the pisiform which is rarely involved. The distal carpal row may be normal and often the carpometacarpal joints are not involved. In cases of long duration it is not uncommon to find natural fusion between the navicular greater and lesser multangular bones. In one case all the carpal bones except the lunate were completely fused together and to the radius. In no case in this series was the first carpometacarpal joint involved.

When tendon and synovial sheaths are diseased, marked swelling is present due to edematous and gelatinous synovial lining. This occurred 3 times in 23 cases.

Proof of diagnosis. Tuberculosis should always be proved either by frozen tissue section permanent tissue section, or guinea pig inoculation. Every case in this series was so proved. Although

one patient died of carcinoma of the throat 15 months after wrist fusion, check up of the original sections of the wrist tissues revealed them to be typical of tuberculosis. In one case no typical tuberculous areas were seen upon inspection at operation but frozen section examination of the tissues was positive for tuberculosis. In another the smear of pus from the wrist was positive for tuberculosis.

In the 13 cases in which it was done the Mantoux test was positive. The Wassermann test was negative in each case except one but in this exception the frozen section and guinea pig diagnoses were positive for tuberculosis.

Sinus formation. Before operation sinuses were not present in any of the 23 cases. Following operation sinus formation occurred 7 times. Three healed within 6 to 8 weeks. Another remained open until refusion of the wrist was performed 6 months later. Two continued to drain until the hands were amputated at 9 and 12 months, respectively. Another drained until the patient died 15 months after operation.

Postoperative treatment. Two weeks after operation if there are no complications, the sutures are removed, a snug well fitting plaster cast is applied, and the patient is discharged from the hospital. The plaster cast is worn from 12 weeks to 6 months depending upon the progress of the fusion. The period of immobilization averages about 3 to 4 months. After removal of the cast a sling is worn temporarily and gentle massage, hot soaks, light elbow and finger exercises are given.

End results. For purposes of clarity the end results are classified in two different ways: (1) As to cure of the disease. This is the most important classification because the primary purpose in the treatment is to cure the local tuberculous lesion. It is well known that a complete and solid fusion be it by surgical or natural means does produce a cure. (2) As to anatomical, symptomatic, and functional results. In this classification which is the most comprehensive not only is the state of fusion considered in regard to the presence or the absence of a cure but symptoms and function are also discussed and evaluated upon a numerical basis.

The end results are based upon a follow up period ranging from 1 to 13 years except for 2 cases of 6 and 9 months each. The 3 patients who disappeared and the 3 who died are not included in these figures. This leaves an average follow up period of 3.6 years.

Results as to cure (Table II). It can be said definitely that 12 of the 23 patients were cured. It is not known why fusion cures tuberculosis but



Fig 10.

Fig 10 Fracture-dislocation of wrist. Anteroposterior views before and after operation. Note restoration of alignment after proximal row of bones has been removed and head of capitate bone has been buried in end of radius.



Fig 11.

Fig 11 Volkmann's paralysis following fracture. Lateral roentgenograms. In left print note the degree of flexion deformity before operation and in right print the degree of extension after operation.

observation shows that once a tuberculous joint becomes completely solid, with the disease subsided, disease does not recur in that joint. Eight fusions became solid following the first operation, and judged roentgenographically, fusion in these cases occurred at 3 months in 2 cases, at 6 months in 2 cases, at 7 months in 1 case; at 9 months in 1 case, and at 12 months in 2 cases. Three additional fusions became solid after a second operation and 1 after a third operation.

Another case showed fusion of the radiocarpal joint at 9 months but the ulnar head became involved and had to be resected. At the time of resection, the radiocarpal joint was found to be solid. Since tuberculosis does not spread from a solid fusion area, the ulnar head must have become infected in the manner previously described, during the period the wrist was undergoing fusion.

Eleven patients developed pseudarthroses. Four of these obtained a solid fusion, as stated. Three patients refused to have the pseudarthrosis repaired. One patient with a pseudarthrosis died of carcinoma of the throat 15 months after wrist fusion had been attempted, and another died 3 months after operation from active pulmonary tuberculosis which was present before operation. Amputation was performed in the 2 remaining cases. The latter were white males, aged 58 and 69, who gave a history that 18 and 9 months earlier they had fallen and injured the right and

left wrist, respectively. Both had been treated elsewhere by hot applications and massage. At operation pus was present in each wrist and by guinea pig inoculation the tissues were positive for tuberculosis. Sinuses formed, fusion did not take place, and the wrists and hands became useless from extensive disease. Twelve and 9 months after attempted wrist fusion, amputation at the lower fourth of the forearm was performed. One patient died 3 months later of pulmonary tuberculosis which had been present over 2 years. The older man lived.

2. *Results as to anatomy, symptoms, and function.* The 23 cases were graded on the basis of 4-4-4 for perfect anatomical, symptomatic, and functional results. In discussing Table III inversely, 3 patients moved to Colorado, Italy, and Japan, soon after operation was performed and end-results remained unknown.

Failures occurred in 4 cases through amputation or death. These were discussed previously.

TABLE III—END-RESULTS AS TO ANATOMY, SYMPTOMS, AND FUNCTION, OF SURGICAL FUSION OF THE WRIST FOR TUBERCULOSIS

Result	Cases
Perfect (4-4-4)	
Good (3-3-3 to 4-4-4)	
Fair (3-3-2)	
Poor (1-2-2, 1-3-2, and 0-1-2)	
Failure (amputation, death, or both)	
Unknown (moved away)	



Fig 12

Fig 12 Spastic paralysis affecting wrist before operation. Note flexion of fingers in anteroposterior view and of wrist in lateral view.



Fig 13

Fig 13 Same case after operation. Note extension of fingers in anteroposterior view and of wrist in lateral view after removal of proximal row of bones and fusion of wrist.

In the 3 results rated as poor the fusions were incomplete but the disease was quiescent. The patients were greatly improved and had returned to their vocations of housewife, nurse, and waitress, which they previously had had to give up and which they now accomplished satisfactorily except for fatigue and aching at night after a day's hard work.

A fair result (3 3 2) occurred in 1 case. The disease was cured but because the wrist became solid in slight ulnar deviation instead of neutral lateral position and in 10 degrees extension rather than 25 to 30 degrees extension only an anatomic 3 was given. The patient returned to his old occupation as cabinet maker but because his efficiency was not as great as formerly and because he lacked complete flexion of the fingers, although extension was good, a functional 2 was allotted. With light work he suffered no symptoms, but after heavy work temporary stiffness of the fingers occurred. Also slight twinges of pain were present with changes in weather, so a symptomatic 3 was given.

Good results were obtained in 8 patients the grading being from 3 3 3 to 4 4 4 as follows: three 4 4 3's, two 4 3 4's and one 3 3 4, 3 4 4 and 4 3 3. The joint became solid and a cure was obtained in each case. A 3 instead of a 4 was given, however, because of such conditions as inability to make a tight fist, occasional pain in bad weather, and slight adduction deformity of the hand.

Perfect results (4 4 4) occurred in 4 cases. Such rating indicates that a cure of the local lesion was

obtained with the wrist solidly fused in excellent position, that no limitation of function of the hand and forearm was present, and that the patient was symptom free.

Conservative treatment. For comparative purposes a study was made of all the records from 1905 to 1933 of patients with tuberculosis of the wrist who had been treated conservatively and without operative interference. There were 52 such records. The range of age was from 2 years to 60 years. There were 12 more males than females but the site of affliction was practically equally divided between right and left. Diagnosis of tuberculosis was made by the history, examination, roentgenograms, aspiration, biopsy, in 1 case, sinus formation and the course of the disease. Treatment consisted of immobilizing procedures such as strapping, casts and braces. The follow-up period ranged from 3 months to 18 years with an average of 3.9 years.

Only 8 of the 52 patients were relieved of their symptoms and 1 of these continued to have intermittent pain after wearing a brace for 2 years. Sinuses were frequent, some draining for as long as 2 years. Braces were worn in each case. It is important to note that as the wrists became asymptomatic motion also became markedly limited.

None of the 44 remaining patients was relieved. Many were discouraged. Twenty-seven sought treatment elsewhere. After wearing a brace 9 years, 1 patient still suffered pain and spasm of the wrist and hand. Four died. One of these developed tuberculosis of the knee 3 months after

the onset of the disease at the wrist and died of pulmonary tuberculosis 18 years later, still wearing a brace. Amputation was necessary for 1 patient. Another developed tuberculosis between the tenth and twelfth thoracic vertebrae 3 years after involvement of the wrist. The foot and spine became affected in another case. Active pulmonary tuberculosis was diagnosed in 3, and no doubt existed in many more.

On the other hand 2 patients developed tuberculosis of the wrist from other foci. One of these had had a draining tuberculous hip and shoulder for 10 years before the wrist became diseased, and finally died 2 years later of tuberculous meningitis. The other had a draining tuberculous sacroiliac joint for 5 months before the wrist became affected, and this was followed by tuberculosis of the knee.

Table IV allows comparison of the results obtained from operative and conservative treatment of tuberculosis of the wrist.

CONDITIONS OTHER THAN TUBERCULOSIS OF THE WRIST

Fusion of the wrist was performed upon 21 patients suffering from rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture-dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis. The cases under each condition will be given in detail. The method of fusion follows the same general principles as were discussed under tuberculosis. Variations of importance, however, are mentioned below.

When adduction deformity of the hand is severe it is necessary, in order to obtain correction, to remove wedges of bone from the lateral aspect of the radius and navicular bones. In addition, lengthening of the flexor carpi ulnaris tendon may be necessary also before the hand can be placed in neutral lateral position.

When flexion deformity of the hand is present or the fingers are contracted, it is wise to remove the proximal row of carpal bones, i.e., navicular, lunate, and triquetrum. The flexion deformity of the hand thus can be overcome easily. At the same time, this will give more motion to the fingers or will allow them to retain the same amount of motion after the wrist is extended as was present in flexion. If the flexion deformity and contracture of the fingers is severe, stretching by the Jones splint should be carried out before operation, and after operation the fingers should be held hyperextended as much as possible.

When tendon sheaths have been destroyed, plastic implantation of adipose tissue may aid materially in improving finger function by pre-

TABLE IV.—COMPARISON OF END-RESULTS IN THE OPERATIVE AND CONSERVATIVE TREATMENT OF TUBERCULOSIS OF THE WRIST

	Operative		Conservative	
Average length of follow-up...	3.6 years		3.9 years	
Number of patients treated....	23		52	
Number disappeared	3		27	
Total remaining for follow-up study	20		25	
	Cases	Per cent	Cases	Per cent
Cured	12	60	0	0
Relieved	4	20	8	32
Not cured	4	20	17	68

venting adhesions between the bare bone and the bare tendons.

When bone circulation appears to be poor, as it is in hard, eburnated bone, fusion may be aided by placing drill holes in the distal end of the radius and surrounding carpal bones.

Fusion is also encouraged by establishing a stable fusion area. This can be done best at the wrist, in those cases in which it is necessary to remove the proximal row of bones, by cutting a recess into the radius to admit snugly the denuded head of the capitate bone. Such can be performed with impunity when the distal radial epiphyseal line is closed but with care otherwise. When the radial epiphysis is too small to allow for the carrying out of such a procedure, the head of the capitate is removed in order to approximate the carpal bones and radius.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis of the wrist is a very incapacitating condition producing a swollen joint that is painful and weak, allowing little use of the hand. In selected cases in which the joint has become so disorganized that it is not amenable to conservative treatment, elimination of pain and restoration of function to the hand may be accomplished by wrist fusion.

Four patients, 3 females and 1 male, ranging in age from 17 to 37 years, were so treated. Symptoms had been present from 2 to 9 years except for 1 acute case of 2 months' duration. All had received the usual anti-arthritis treatment of heat, massage, exercises, salicylates, supports, x-rays, and attention to foci of infection. Examination revealed warm, red, swollen joints with severe spasm and pain upon attempted motion. Anteroposterior motion was only 10 to 20 degrees associated with full pronation, limited supination, and absent lateral motion. The roentgenograms showed decalcification, thinning of the cartilage spaces, and effusion.



Fig 12

Fig 12 Spastic paralysis affecting wrist before operation. Note flexion of fingers in anteroposterior view and of wrist in lateral view



Fig 13

Fig 13 Same case after operation. Note extension of fingers in anteroposterior view and of wrist in lateral view after removal of proximal row of bones and fusion of wrist

In the 3 results rated as poor the fusions were incomplete but the disease was quiescent. The patients were greatly improved and had returned to their vocations of housewife, nurse, and waitress which they previously had had to give up and which they now accomplished satisfactorily except for fatigue and aching at night after a day's hard work.

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Perfect results (4 4 4) occurred in 4 cases. Such rating indicates that a cure of the local lesion was

obtained with the wrist solidly fused in excellent position, that no limitation of function of the hand and forearm was present, and that the patient was symptom free.

Conservative treatment. For comparative purposes a study was made of all the records from 1905 to 1933 of patients with tuberculosis of the wrist who had been treated conservatively and without operative interference. There were 52 such records. The range of age was from 2 years to 60 years. There were 12 more males than females but the site of affliction was practically equally divided between right and left. Diagnosis of tuberculosis was made by the history, examination, roentgenograms, aspiration, biopsy in 1 case, sinus formation and the course of the disease. Treatment consisted of immobilizing procedures such as strapping, casts and braces. The follow up period ranged from 3 months to 18 years with an average of 3.9 years.

Only 8 of the 52 patients were relieved of their symptoms and 1 of these continued to have intermittent pain after wearing a brace for 2 years. Sinuses were frequent, some draining for as long as 2 years. Braces were worn in each case. It is important to note that as the wrists became asymptomatic motion also became markedly limited.

None of the 44 remaining patients was relieved. Many were discouraged. Twenty seven sought treatment elsewhere. After wearing a brace 9 years, 1 patient still suffered pain and spasm of the wrist and hand. Four died. One of these developed tuberculosis of the knee 3 months after

the onset of the disease at the wrist and died of pulmonary tuberculosis 18 years later, still wearing a brace. Amputation was necessary for 1 patient. Another developed tuberculosis between the tenth and twelfth thoracic vertebrae 3 years after involvement of the wrist. The foot and spine became affected in another case. Active pulmonary tuberculosis was diagnosed in 3, and no doubt existed in many more.

On the other hand 2 patients developed tuberculosis of the wrist from other foci. One of these had had a draining tuberculous hip and shoulder for 10 years before the wrist became diseased, and finally died 2 years later of tuberculous meningitis. The other had a draining tuberculous sacroiliac joint for 5 months before the wrist became affected, and this was followed by tuberculosis of the knee.

Table IV allows comparison of the results obtained from operative and conservative treatment of tuberculosis of the wrist.

CONDITIONS OTHER THAN TUBERCULOSIS OF THE WRIST

Fusion of the wrist was performed upon 21 patients suffering from rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture-dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis. The cases under each condition will be given in detail. The method of fusion follows the same general principles as were discussed under tuberculosis. Variations of importance, however, are mentioned below.

When adduction deformity of the hand is severe it is necessary, in order to obtain correction, to remove wedges of bone from the lateral aspect of the radius and navicular bones. In addition, lengthening of the flexor carpi ulnaris tendon may be necessary also before the hand can be placed in neutral lateral position.

When flexion deformity of the hand is present or the fingers are contracted, it is wise to remove the proximal row of carpal bones, i.e., navicular, lunate, and triquetral. The flexion deformity of the hand thus can be overcome easily. At the same time, this will give more motion to the fingers or will allow them to retain the same amount of motion after the wrist is extended as was present in flexion. If the flexion deformity and contracture of the fingers is severe, stretching by the Jones splint should be carried out before operation, and after operation the fingers should be held hyperextended as much as possible.

When tendon sheaths have been destroyed, plastic implantation of adipose tissue may aid materially in improving finger function by pre-

TABLE IV.—COMPARISON OF END-RESULTS IN THE OPERATIVE AND CONSERVATIVE TREATMENT OF TUBERCULOSIS OF THE WRIST

	Operative 3 6 years	Conservative 3 9 years
Average length of follow-up	3 6 years	3 9 years
Number of patients treated	23	52
Number disappeared	3	27
Total remaining for follow-up study	20	25
	Cases Per cent	Cases Per cent
Cured	12 60	0 0
Relieved	4 20	8 32
Not cured	4 20	17 68

venting adhesions between the bare bone and the bare tendons.

When bone circulation appears to be poor, as it is in hard, eburnated bone, fusion may be aided by placing drill holes in the distal end of the radius and surrounding carpal bones.

Fusion is also encouraged by establishing a stable fusion area. This can be done best at the wrist, in those cases in which it is necessary to remove the proximal row of bones, by cutting a recess into the radius to admit snugly the denuded head of the capitate bone. Such can be performed with impunity when the distal radial epiphyseal line is closed but with care otherwise. When the radial epiphysis is too small to allow for the carrying out of such a procedure, the head of the capitate is removed in order to approximate the carpal bones and radius.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis of the wrist is a very incapacitating condition producing a swollen joint that is painful and weak, allowing little use of the hand. In selected cases in which the joint has become so disorganized that it is not amenable to conservative treatment, elimination of pain and restoration of function to the hand may be accomplished by wrist fusion.

Four patients, 3 females and 1 male, ranging in age from 17 to 37 years, were so treated. Symptoms had been present from 2 to 9 years except for 1 acute case of 2 months' duration. All had received the usual anti-arthritis treatment of heat, massage, exercises, salicylates, supports, x-rays, and attention to foci of infection. Examination revealed warm, red, swollen joints with severe spasm and pain upon attempted motion. Anteroposterior motion was only 10 to 20 degrees associated with full pronation, limited supination, and absent lateral motion. The roentgenograms showed decalcification, thinning of the cartilage spaces, and effusion.

The presence of the above findings caused 3 of the 4 patients to be observed for tuberculosis because it was ruled out. Cultures and Wassermann reactions were likewise negative. But fusion was done because of the pathological findings of thick gray edematous synovial membrane, thin cartilage that separated easily, and soft bones showing areas of erosion. Occasionally fibrous tissue was found between the bones, and in the acute case of only 2 months' duration, the presence of seropurulent fluid and a small amount of caseous material caused the surgeon to make a macroscopic diagnosis of tuberculosis but careful microscopic examination of the tissue did not prove this. The complement fixation test for gonococcus was also negative in this case.

The operations were carried out in the routine manner by removing the cartilage from all bones except the pisiform and the greater multangular, and placing bone chips in the intercarpal spaces.

In one case the sheaths of the extensor tendons had become thickened and edematous with destruction of the anterior portions. As is well known, adherent tendons with resultant impaired finger motion are a serious handicap. Therefore, a layer of fat was taken from the thigh and transplanted over the bone in order to prevent adhesions between the bare bone and overlying tendons through the destroyed anterior portion of the tendon sheaths. Active finger motion was started on the fourth day after operation and in 6 weeks motion of the fingers was complete. Five and one half years later a perfect functional result was still present; furthermore, this was the only one of the 4 cases that did have a perfect end result.

In all 4 cases healing of the incision was *per primam* without sinus formation. Plaster casts were worn from 3 to 5 months and the fusions became solid within 3 to 6 months.

Grading on the basis of 4 4 4 for perfect anatomical, symptomatic, and functional results in the order named, the results were 4 4 4 4 4 3 4 4 2 and 2 4 3. These end results were in turn based upon a follow up period ranging from 5½ to 12 years with an average of 8 years.

Three of the 4 wrists became solid in proper position and received an anatomical 4. But a 2 was given in the other case because the wrist became solid in ulnar deviation rather than neutral lateral position and because rotation was limited.

Each case received a symptomatic 4 because each patient became free of all wrist symptoms. Heavy use of the hand was no longer painful. One patient stated that now he could drive a taxi all

day without pain or fatigue. One woman was well pleased because she could not sew or pick up objects before operation while afterward she accomplished such with ease. Ironing also became a painless task.

The greatest mark down came in the functional group. Arthritis of the fingers limited finger motion and lessened the grip in 3 cases. Although such was present before operation a perfect functional result was not given.

OBSTETRICAL PARALYSIS

The lower arm type of obstetrical paralysis (Klumpke's) offers the best results from wrist fusion because in spite of the drop hand the shoulders and elbow muscles are adequate. The operation can also be of value in the whole arm type of paralysis, but here the musculature of the entire extremity is generally so poor that nothing better than a cosmetic result can be expected. The upper arm type (Erb's) does not give a drop hand thus allowing no indication for wrist fusion.

A 16 year old boy suffered paralysis of the left upper extremity at birth. Treatment elsewhere consisted of electrical stimulation, massage, and transplantation of the wrist flexors to the dorsum of the hand without resultant improvement.

Examination of the musculature of the left upper extremity revealed good power in the flexor and adductor muscles at the shoulder while the remaining shoulder muscles were poor in power. Elbow musculature was good except for fair pronator and supinator muscles. At the wrist the flexors were fair and the extensors poor while the fingers showed good flexor and fair extensor power. The wrist was held in 30 degrees adduction and flexion and no active extension was possible.

At operation the cartilage was removed from the radius, navicular and lunate bones. A wedge of bone also was removed laterally in an attempt to correct the ulnar deviation. The fusion became solid in 4 months and the plaster cast was removed.

Four years 8 months later the patient was rated as a 2 4 4 result. An anatomical 2 was given because although the wrist had become solid in extension a 20 degree adduction deformity persisted which the patient did not like for cosmetic reasons. In addition rotation was limited to 75 degrees pronation and 45 degrees supination.

A symptomatic 4 was given because there were no symptoms even in bad weather.

Excellent function gave a functional 4 result. The patient stated that the operation was of great value and had given more strength to the entire arm. The grip was now almost equal to that of the normal side. Formerly the tighter he grasped the more flexion occurred at the wrist with a corresponding weakness of grip. Now with the hand extended the grip was more certain, stronger and of greater duration. For the first time he could button his shirt and dress himself with this hand.

POLIOMYELITIS

Wrist fusion in poliomyelitis is of value not only in the classical case of good flexor and absent

extensor muscles, but also in combination with shoulder fusion when the extremity is practically flail. It may also be used for cosmetic purposes when the hand is flail, useless, and dangling at the side in poor position.

The ages of the 2 girls and 1 boy so treated varied from 12 to 19 years, and they had not had full use of the affected upper extremity for 10 to 18 years.

One had good musculature at the shoulder and elbow but no power at the wrist and hand except for poor flexors of the fingers, resulting in the hand being held in 70 degrees of flexion and 60 degrees of pronation. After operation upon the wrist, at which time the first row of bones (navicular, lunate, and triquetral) was removed and the radius fused to the capitate and lesser multangular bones, the fusion became solid with the hand in extension and neutral lateral position; there were no symptoms except slight pain in the last 10 degrees of passive extension to 180 degrees due to the fingers remaining somewhat contracted as they were before operation, and the patient was able to drive a car for the first time in his 19 years of life. A grading of 4-3-3, based on a 3 year 3 month follow-up, was given this case.

Another had a flail shoulder and elbow with fair flexors and poor extensors at the wrist in addition to poor power in the fingers. Due to fair adductors and absent abductors the wrist presented an adduction deformity. To correct this the flexor carpi ulnaris tendon was lengthened and a wedge of bone was removed from the navicular and radius. Fusion was carried out by removing the cartilage from the first and second row of bones. Three months later the wrist was solid. Two years and 2 months afterward there were no symptoms. Cosmetically the hand was improved by the better position and for this a 2 was given. Otherwise the hand was no more useful than before. Fusion in good position, without symptoms, and with the hand cosmetically improved, gave a rating of 4-4-1.

The third case presented a flail shoulder and wrist with good musculature at the elbow. The child was 12 years old and fusion of the shoulder and the wrist were performed at the same time, the wrist by macerating the carpal bones, end of the radius, and bases of the metacarpals, after their cartilages were removed. The result 9 years 4 months later was a solid wrist and shoulder with the wrist at 180 degrees and in 5 degrees of adduction instead of 30 degrees' extension and neutral lateral position, for which an anatomical 3 was given. There were no symptoms—a symptomatic 4. Functionally, the patient could now hold a knife and fork, type write, dress herself, and open doors—things she could not do before operation. A firm grasp was present due to good flexor muscles functioning against a fused wrist. The patient herself was well pleased. This was a very good result considering the extensive paralysis, and a functional 3 was granted, making the rating 3-4-3.

FRacture-DISLOCATION

For injuries that completely disrupt the continuity of the wrist, allowing no recourse to open or closed reduction, fusion offers the quickest, most effective, and permanent relief.

In one case a 44 year old man fell 35 feet receiving a fracture-dislocation of the left wrist (Fig. 10) in addition to fractures of the left tibia, second lumbar vertebra, and right radius.

At operation the proximal row of carpal bones (navicular, lunate, and triquetral) was removed. The cartilage was removed from the radius, capitate, and hamate bones. A recess was cut into the radius to admit the denuded head of the capitate bone which was sutured to the radius.

The result 3 years 4 months later was 4-4-4 with the fusion solid in good position; with no pain or other symptoms, and with good function without disability.

Another case was that of a longshoreman who fell from a similar height and received a fracture of the radius which united with shortening and overlapping of the fragments, causing a 30 degree abduction deformity of the hand. Function and strength were so poor that the patient had to give up work. At the time of wrist fusion drill holes were placed in the radius and surrounding carpal bones for stimulation of circulation. The follow-up 4 years 10 months later revealed fusion between the radius and lunate but none between the radius and navicular bones, and motion was from 15 degrees' flexion to 25 degrees' extension. For lack of fusion a zero was given. Symptomatically, however, the patient received a 4 because there was no pain, spasm, tenderness, or swelling, even in bad weather. A 4 also was given for function. There was good musculature and circulation. Finger motion was complete and strong, with the grip being almost equal to the normal side. He returned to work as a longshoreman upon removal of the cast 3 months after operation and stated nearly 5 years later that he could do any work anyone else could. He was very well pleased. The rating given was 0-4-4.

VOLKMAN'S PARALYSIS

Volkman's paralysis (Fig. 11) offers a poorer prognosis than any of the conditions for which wrist fusion may be done because the shiny, stiff, board-like extremity is generally beyond functional improvement. However, the patient can be improved cosmetically when flexion deformity is present by fusing the wrist with the hand in good position.

Such was done for 2 patients who had suffered Volkman's paralysis 1 and 14 years earlier. Both had flexion deformities of the right hand of 25 and 60 degrees, respectively, with only 20 degrees of anteroposterior motion. The flexion deformity had been wedged out by plaster casts and a brace worn, but each time the deformity recurred upon removal of the brace.

At operation the proximal row of bones (navicular, lunate, and triquetral) was removed in an attempt to relax the flexor tendons and overcome their contracture. Though this did not improve the function of the fingers in 1 case it kept them from contracting further because with the hand solid in extension there was as much finger motion as there had been before operation. Grasping in both cases was carried out with the fingers, which moved one-third of normal, and the strong, freely movable thumb. Both patients were pleased and at ease with a stiff wrist in extension rather than with the former one in flexion. One was free of all symptoms while the other continued to be sensitive to burns due to the previously impaired sensation.

Ratings of 2-2-2 and 2-4-0 were given on a follow-up basis of 4 years, and 1 year 5 months.

GONORRHEAL ARTHRITIS

Gonorrheal arthritis rapidly produces fibrous or bony ankylosis at the wrist and if, during the

activity of the disease, the hand is placed in proper position there need be no reason later for wrist fusion. However, when such wrists become ankylosed in poor position they must be corrected. In this case the 30 degree flexion deformity did not allow the patient to flex the fingers completely. She also suffered pain in bad weather and upon lifting.

At operation there were 10 degrees of motion at the radiocarpal joint while the remaining carpus was a solid mass of hard and enurated bone. Chips from the mass were taken to fuse the radiocarpal joint. The wrist became solid within 3 months in 15 degrees extension. Because 30 degrees extension would have been better an anatomical 3 was given. There was no swelling, pain, tenderness or spasm but because of an occasional numbness of the fingers and stiffness after washing clothes a symptomatic 3 was given. Due to 75 degrees of supination instead of 90 and a grasp weaker than the normal side a functional 3 was given.

These findings based on a 3 year 8 month follow up study gave a 3 3 3 result.

SPASTIC PARALYSIS

Wrist fusion offers much for the unfortunate victim of spastic paralysis (Figs. 12 and 13). The usual deformity of a flexed hand which the patient generally is unable to extend actively, associated with hyperextension or hyperflexion of the fingers is a well known condition. In the mild cases fusion improves function by placing the hand in extension allowing better strength and motion of the fingers. In the severe cases the spasticity prevents good finger function, but cosmetically the bad position is overcome by fusion which in turn eases the patient's embarrassment and improves the morale. In a sense also, function of the extremity is improved in that it is much easier to put the straight hand through a coat sleeve or in a pocket than when the hand is in severe flexion.

Eight patients of both sexes ranging in ages from 13 to 25 years and suffering the deformity the same length of time received wrist fusions for deformity resulting from spastic paralysis. Each patient complained of inability to extend the hand completely, lack of strength due to the flexion deformity, inability to eat, write and lace shoes and failure of precision in handling small objects.

All had been under treatment at this hospital from 4 to 19 years receiving exercises, massage and braces. Previous operations included transplantation of the flexor carpi ulnaris and radialis to the extensors of the fingers and cervical resection.

The deformity varies according to the patient but generally the elbow is flexed, the forearm pronated 90 degrees, the wrist flexed 45 degrees and adducted 45 degrees and the fingers extended except for the thumb which is held adducted. Most of the patients can open their hands in flexion but in this position the grip is always poor. Others have full range of finger motion but fine movements are labored, inco-ordinate and uncertain. Rarely is there free motion of the elbow and shoulder but when such is present

the functional result of the hand after operation is much better.

The operating time varied from 39 minutes to an hour and one half. In 5 of the 8 cases the proximal row of bones was removed in order to accommodate the shortened flexors of the fingers. Such was not done in the 3 other cases because good finger motion was present before operation.

When the navicular, lunate and triquetrum bones are removed the cartilage is excised from the distal end of the radius proximal and lateral aspects of the lesser multangular proximal, medial and lateral aspects of the capitate, and proximal and medial aspects of the hamate bones. A cavity is then made in the radial articular process care being taken not to injure the epiphyseal line if it is not closed and the head of the capitate is snugly buried in the radius. Small bone chips from the radius are placed where necessary. A long arm cast with the wrist in 25 to 30 degrees extension and neutral lateral position and the fingers in 45 degrees extension in order to stretch the flexor muscles is applied. The cast should extend to the finger tips and because the thumb generally presents an adduction deformity it should also be encased in plaster and held widely abducted.

Cast is worn from 2 to 4 months. Those worn the shortest period of time showed less finger motion due to the rapid contracture of the fingers indicating that holding the finger flexors stretched for a longer period of time improves finger function. For this reason most casts now are left on for a period of 16 weeks. After removal of the cast, hot soaks, massage and a sling are given for the wrist plus light exercises for the elbow and the fingers.

All fusions became solid within 2 to 4 months except for 1 case which developed a pseudarthrosis.

One patient was omitted from the end result study because she ignored requests to return for observation. The roentgenogram 3 months after operation revealed fusion to be present but because a longer follow up could not be obtained the case was eliminated from this series. The average follow up period for the 7 remaining cases was 1 year 2 months.

A complete failure (0-0-0) was the end result in 1 case. A 90 degree flexion deformity of the hand with the flexor muscles of the fingers tight and spastic was present before operation. After operation the radius became fused to the navicular and lunate bones but after removal of the cast motion was present between the 2 rows of bones and between the distal row and metacarpal bones. Soon thereafter the pull of the tight finger flexor muscles caused the hand to assume the position of 35 degrees flexion. Although this was better than 90 degrees flexion it was insufficient to improve function or appearance. If the proximal row of bones had been removed in order to accommodate the short, spastic flexor tendons and if the carpometacarpal joints had been fused along with the radiocarpal joint a different result might have been obtained. For lack of a complete fusion an anatomical zero was given. Following operation passive motion was painful so a symptomatic zero was given. A functional zero was also allotted because the hand was neither more useful nor better in appearance than before operation.

Fair results (4 4 4 4 4 3 3) were obtained in 1 case. Solid fusion in good position without symptoms occurred in 2 cases for an anatomical and symptomatic 4, while fusion in slight ulnar deviation plus the presence of slight pain reduced the rating to a 3 in the other case. Functionally none of the patients gained much finger motion in spite of the removal of the proximal row of carpal bones and the fingers remained spastic and uncontrollable. However, there was improvement in the appearance of the hand

TABLE V—SUMMARY OF END-RESULTS IN ALL CASES OF SURGICAL FUSION OF THE WRIST JOINT

Condition	Cases	Perfect	Good	Fair	Poor	Fail-ure	Un-known
Tuberculosis	23	4	8	1	3	4	3
Rheumatoid arthritis	4	1	2	1			
Obstetrical paralysis	1		1				
Poliomyelitis	3		2	1			
Fracture-dislocation	2	1		1			
Volkman's paralysis	2				2		
Gonorrheal arthritis	1		1				
Spastic paralysis	8	1	2	3		1	1
Total	44	7	16	7	5	5	4

and this pleased the patients very much. Because of the cosmetic improvement a grading of 1 was given.

Good results (3-4-3, 4-4-3) occurred twice. One patient (3-4-3) had developed a pseudarthrosis following wrist fusion 2 years earlier. A second fusion was done because of pain, weak grip, loss of active extension of the fingers, and poor appearance of the hand. The wrist became solid at 180 degrees instead of 205 to 210 degrees and an anatomical 3 was given. No longer was there any pain, a symptomatic 4. The grip was now strong, there was complete active extension and flexion of the fingers, and the appearance of the hand was no longer embarrassing because it was straight instead of flexed. The patient stated that the whole arm could be used better. Muscle power increased and there was improvement in voluntary function and control. A functional 3 was allotted.

The end-result of the other case (4-4-3) was equally as interesting because operation was agreed to for cosmetic reasons only. Fusion occurred in good position and there was no pain, an anatomical and symptomatic 4. Before operation the grip was quite weak and there was no finger motion except a few degrees' flexion. Eleven months after operation the grip was fair and there was complete active flexion of the fingers. Extension, though, remained limited. She could pick up objects more easily and stated that no longer was it necessary to use her good hand to assist the affected arm in putting on a dress or coat. Being a girl, she was extremely pleased that people no longer noticed the previously deformed hand. A functional 3 was granted.

A perfect end-result (4-4-4) occurred only once. The wrist became solid in proper extension and excellent lateral position. There were no symptoms. The grip was good. There was full range of active extension and flexion of the fingers. The patient stated that cosmetically the hand was very much better and that functionally the wrist and hand were at least twice as useful as before.

SUMMARY

1. Forty-four cases of surgical fusion of the wrist joint for tuberculosis, rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture-dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis, are presented.

2. A theory as to the etiology of secondary

tuberculous involvement of the ulnar epiphysis in tuberculosis of the wrist joint is offered.

3. Tourniquet, operative, and plaster techniques are discussed.

4. The operative and non-operative treatments of tuberculosis of the wrist joint are compared.

5. The proper functional position for a solid wrist joint is given.

6. End-results from an average follow-up period of 4.1 years are listed in detail.

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MACROCHEILIA DUE TO HYPERPLASIA OF THE LABIAL SALIVARY GLANDS, OPERATIVE CORRECTION

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MACROCHEILIA may be defined as an abnormal or excessive size of the lip. Under this heading the literature includes a number of conditions, either inflammatory or neoplastic in character. Abnormal enlargement of the lip, admittedly rare in occurrence, is given little emphasis in the standard references and texts of this day. One author (19) refers to macrocheilia as due to simple lymphangioma of the lip. Another (35) states that certain of the enlargements of the tongue and lip, known as macroglossia and macrocheilia, are undoubtedly lymphangiomatous in nature. In a third text (5) it is noted that only in recent years have many examples of an exaggerated appearance of the labial glands throughout the mouth been seen. The histories of cases reported in the literature often give such meager accounts of the clinical and pathological data pertaining to the condition that accurate classification of reported cases is not possible. My recent experience with 3 cases of macrocheilia of the upper lip in which pathological examination of tissue removed at operation showed the enlargement to be due to increase in the size and the number of labial salivary glands has led me to the conclusion that this condition is more common than formerly believed and that many cases of this type are erroneously diagnosed as lymphangiomas.

Macrocheilia, when associated with ulceration usually may be diagnosed clinically. Syphilis, carcinoma, and tuberculosis of the lip may be differentiated by the well known characteristic signs of these pathological entities. In the absence of ulceration, however, the diagnosis is more difficult. Macrocheilia without ulceration may be due to simple hyperplasia of the submucous salivary glands, to lymphangioma or lymphangiectasis, to elephantiasis or to hemangioma. Of these hemangiomas are easily differentiated by the compressibility of the swelling, its increase in size when the head is placed in the dependent position, the presence of varicosities beneath the surface of the skin or mucous membrane and by the usually asymmetrical contour of the swelling. True elephantiasis of the lip may be ruled

out by the characteristic appearance of its thickened and hypertrophic folds of skin and mucous membrane. Macrocheilia due to hyperplasia of the labial salivary glands is not easily differentiated clinically from lymphangioma in the same location. Both conditions present a diffuse enlargement of the lip, non edematous, non compressible, non ulcerative. The etiology of both is obscure. To add to the diagnostic difficulty, perusal of the literature reveals that there also exists confusion in nomenclature. The term macrocheilia has been used to group a number of cases in which the reports give no data regarding histopathology but the lesion is presumed to be lymphangiomatous. Again, cases of simple hyperplasia of the labial glands are referred to as adenomas of the lip though no evidence of encapsulation of tumor tissue is present. Under the term double lip, a few authors have reported cases with details of operative correction of the deformity but without complete data regarding histopathological examination of the tissue removed. In the German literature there are several records of cases of macrocheilia associated with blepharochalasis and enlargement of the thyroid gland. Referring to these as cases of Ascher's syndrome, subsequent authors attempted to set aside a new clinical entity. Records of similar cases do not appear in later years. Under the names, cheilitis glandularis apostematosa or myxadenitis labialis, Volkmann described as macrocheilia a lesion characterized by elevations representing muciparous glands with dilated follicular orifices which admitted a fine probe and from which mucoid mucopurulent or serous fluid could be expressed. A recent report by New and Kirsch attempts to set aside a new clinical entity based on records of 67 cases of permanent enlargement of the lips and face secondary to recurring swellings and associated with facial paralysis. Their information on pathological examination of biopsy tissue is very meager. They state: "Specimens of tissue were taken for biopsy in a few cases before treatment but nothing was found other than edematous tissue containing lymphocytes." Touraine and Salente have emphasized the precancerous nature of the condition which they designate cheilitis glandularis.

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One of the 3 cases which have been under my personal observation and treatment presented the "double lip" appearance as described in the German literature, this patient has developed mucous fistulas of the type described by Volkmann. Another exhibited recurrent swellings followed by permanent enlargement of the lip associated with facial paralysis as described by New and Kirch. Yet, all 3 have shown the same underlying pathological changes in the tissue of the enlarged lip, namely, hyperplasia of the labial salivary glands. In the case in which there was an associated paralysis of the facial nerve (Case 2), microscopy revealed, in addition, a diffuse inflammation of the submucous tissue. I have preferred to classify these 3 cases under the name "hyperplasia of the labial salivary glands" rather than under the older term "cheilitis glandularis," recognizing that the hyperplasia may occur either with or without evidence of inflammation.

LITERATURE

Bouisson in 1869 referred to tumors of the labial salivary glands and stated that, as yet, these conditions had not been subjected to numerous precise observations. In 1870, Volkmann gave the name *cheilitis glandularis apostematosa* or *myxadenitis labialis* to a syndrome which he had observed in 5 cases, 3 of which had syphilis. The lower lip was affected in all 5. In these cases, careful examination showed that the salivary glands of the lip had become "hempseed size," were swollen and were palpable as uneven masses in unusual number. Everting the mucosa of the lip outward one could see that the excretory ducts were so dilated that a probe could be inserted. By pressure, which caused only mild pain, an opaque, mucous or purulent secretion could be expressed. Wright in 1884 described a case in an 18 year old boy. Swelling of both lips had been present since birth. The glands were palpable beneath the intact mucosa. Successful removal was accomplished by a 2 stage operation. There was no evidence of infection. No microscopic examination was made. In 1892, Miles reported a case of enlargement of the upper lip in which, on gross examination, the labial glands were found to be hypertrophied. In the same year Fraenkel attached the name macrocheilia to an enlargement of the lower lip due to an adenomatous tumor of this region. Reproduction of the drawings of the gross specimen and the microscopic picture are shown in Figure 1. The gross specimen was described as a "pearl-like string of tumors." This patient was a youth of 19 years, and the swelling of the lower lip had been present since the age of

4 years. The lip was so enlarged that closure of the mouth was difficult. The patient was operated upon and a successful plastic result was achieved by Dr Schede. A similar case was reported by Eisendrath in 1904. The patient, a 16 year old boy, had noticed swelling of the lips when 10 years old. Microscopic examination of the tissue removed showed "normal labial mucous gland substance." There was associated ptosis of both eyelids. In 1905, Lindenberger described the case of a man in whom the swelling followed a blow on the lip received 15 years earlier. Gross pathological examination revealed a number of small glands "slightly larger than buckshot." No microscopic examination was made. Donati in the same year described the same condition in a 20 year old man. The swelling in the upper lip had been present for 8 years. The excess tissue was excised and microscopy revealed that the overgrowth was due to enlarged mucous glands. Masera reported 2 cases in 1911. One occurred in a 24 year old woman; another in a youth of 19 years. Microscopic examination proved the tissue to be composed chiefly of numerous acinous labial glands with many excretory ducts. This author believed the macrocheilia of the upper lip to be due to hypertrophy and hyperplasia of the labial mucous glands. Roussel, in 1906, reported a case in which the lower lip had been swollen for 3 years. Mucous fistulas and luetic skin lesions were also present and no report of microscopic examination is given. In 1915, Stelwagon advanced the theory that the enlargement of the lip is due to adenoma of the mucous glands of the lips and is not due to syphilis. He based his conclusion on the clinical reports by Volkmann (5 cases), Sutton (3 cases), Fox (1 case), Schamberg (1 case), and Purdon (4 cases). In the year 1920, Ascher (1) described a case presenting the syndrome of blepharochalasis, struma and double-lip. Wirths (1920) reported a case with similar lid changes and double-lip without the enlargement of the thyroid gland. In 1921, Weve described as "syndrome Ascher" the case of a 27 year old healthy soldier who exhibited blepharochalasis and double lips, both present since the patient was 4 years of age. Later (1922) Ascher (2) described 2 additional cases of the same syndrome. One occurred in a 16 year old school girl, the other in a man of 39 years, who had swelling of the eyelids, double-lip, and painless swelling of both parotid glands. Ascher remarked that, in view of the rarity of blepharochalasis and as well the infrequent occurrence of double-lips, the simultaneous appearance of the two conditions in patients with severe struma was noteworthy. In 1920, Hatton described a case of

macrocheilia of the upper lip due to adenoma of the mucous glands. The patient was a man, aged 26 years. Microscopic section showed numerous mucous glands. Dorrance (1922) reported a case of double lip present for 9 years in a patient 21 years of age. Gross examination of the specimen removed from the upper lip showed enlargement of the labial salivary glands. No microscopic report was given. In 1922, Roedelius described a case of macrocheilia of the lower lip with several small sinuses which admitted a probe and from which mucus was discharged. Roedelius' patient was a 45 year old man. The enlargement of the lip had been present since childhood. In infancy the patient had a plastic operation for harelip. Roedelius advanced the opinion that in patients with congenital harelip the protrusion of the lower lip might be a factor in exciting activity of the mucous glands thus leading to their over growth. In 1930, Meyer reported 2 cases, one a 10 year old school boy and another, a young woman of 23 years. The author commented on the marked abnormality in shape of the alveolar process of the upper jaw in both cases. The operative procedure used in these 2 cases follows: To reduce the enlarged lip to normal size 2 transverse elliptical incisions were made on either side of the midline. Another vertical elliptical incision was made in the midline. Wedgeshaped sections of tissue were removed from all 3 areas. Meyer chose to call the condition ectropion of the lip and stated that the histological examination in the 2 cases showed the membranes, the labial glands and the surrounding tissues to be normal. Rosenstein, in 1932 reported a case of Ascher's syndrome in a 16 year old school girl. In this patient there was enlargement of both lips, a tendency toward hyperthyroidism, and enlargement of the eyelids. Because the enlargement of the lips developed at the onset of menstruation, Rosenstein believed the macrocheilia to be due to a disturbance of the endocrine glands. In 1933, Bejarano reported 2 cases of cheilitis glandularis in association with epithelioma. In both cases it was the lower lip which was involved. The authors admitted that it would be a grave error to generalize on cheilitis glandularis as a genetic factor in epithelioma of the lip. Touraine and Solente (1933-1935) described 2 cases and reviewed 41 cases from the literature. One of their cases was a lesion of the lower lip of 6 months duration in a man 62 years of age. The second enlargement of the lower lip occurred in a woman of 60 years. The lesion was of a few months' duration. In the first case a small spindle cell epithelioma was found at the base of the in-

fundibulum. Of the 41 cases in the literature which they reviewed 12 per cent showed malignant changes and were considered by them as precancerous. Either reported 9 cases in 1933. Of these, 3 showed enlargement of the eyelids in addition to the double lips but none exhibited signs of enlargement of the thyroid gland. The pathological examination is not reported. In 1933 New and Kirch presented 67 patients with localized swellings of the face. Regions involved by the swellings were as follows: upper lip, 38 cases; cheeks, 12 cases; lower lip, 9 cases; nose, 4 cases; eyelids, 3 cases; upper alveolar process, 3 cases. As already stated, in 13 per cent of these there was an associated facial paralysis. No reference is made by these authors to Ascher's reports and they do not comment on the concomitant swelling of eyelids and lips in the same patient. As stated before, the data regarding pathological examination are very meager in this report. Possibly many of the cases of macrocheilia in this series were due to hyperplasia of the labial salivary glands. Their treatment as outlined involved repeated injections of boiling water into the swollen area. After fibrosis occurred, the redundant tissue was removed by surgical excision. In discussion of the pre-entiation of New and Kirch, Beck has given a meager account of 3 cases, 2 of which had a history of facial paralysis and Wilson briefly reported 4 cases of facial swelling, 1 of which involved the lips.

CASE REPORTS

CASE 1. J. S. (New York Hospital Case No. 15843.) In April 1936 a 28 year old white man a tannery driver by occupation presented himself at the plastic surgery clinic of the New York Hospital with the chief complaint of swelling of the upper lip. He stated that without trauma or other antecedent cause he was startled one morning to find his upper lip previously normal in size swollen to huge proportions. He denied any fistula or counter. There was no injury. The swelling persisted for the 6 years prior to his admission to the clinic without marked variation in size. There was no facial paralysis at any time, no history of any allergic disease. Patient had received frequent treatments for chronic sinusitis of both antra during the previous 6 years. He had reported at several clinics in New York City asking for correction of the deformity of the lip. Each time treatment was deferred. At one institution complete allergic examination was done without significant findings.

Physical examination showed a diffuse enlargement of the entire upper lip so that it protruded in unsightly manner. Palpation of the lip revealed that the enlargement was not due to edema and it was not compressible. There were no varicosities over either the cutaneous or mucous surfaces. No bruit could be heard. On digital pressure the swelling felt shotty. Lowering of the head did not cause an increase in the size of the lip. Examination of the mucous membrane showed no ulceration, fissures or fistulas. The tongue was not enlarged or furrowed. There

was no cervical adenopathy and the thyroid gland was not palpably enlarged. The mucous membranes of the rhinopharynx were hypertrophic, and both antra were cloudy on transillumination. The teeth were in good condition. Pre-operative photographs are shown in Figures 2 and 3. Blood count showed white blood cells, 11,300; hemoglobin 104 per cent.

On April 22, 1936, plastic excision of a large U-shaped wedge of hypertrophied labial tissue was done through an incision in the mucous side of the lip (Fig. 15).

Operation and result. At operation, the tissue was roughly nodular, cut section allowed for the bulging of minute yellowish nodules the size of a pin-head. The fibers of the orbicularis oris muscle were hypertrophied. Bleeding points were ligated with fine catgut and the edges of the wound were approximated with on-end mattress sutures of fine silk. Immediately after operation there was intense swelling of the upper lip. The postoperative edema continued for 6 days despite the constant application of compresses moistened with hypertonic saline and mouth irrigations with the same solution. From that time on the lip slowly decreased in size. Five weeks after operation it appeared approximately normal. The swelling has not recurred since operation was performed 20 months ago. Postoperative photographs are shown in Figures 4 and 5.

Pathology. Pathological examination was made by Dr. N. C. Foot. The specimen consisted of tissue removed from the lip. It measured 6 centimeters in length, 1 centimeter in thickness, and 1 centimeter in width. It was apparently composed of the normal constituents of the lip, but there were numerous node-like masses at the core within the layer of the muscle. There was no evidence of encapsulation. Microscopic examination of the specimen did not show any of the characteristics of lymphangioma. The size of the lip was increased mainly by excessive hyperplasia of the labial salivary glands. These were predominantly mucous in type although some serous cells were found. There was an apparent increase in fibrous tissue. Photomicrograph is shown in Figure 6.

Diagnosis. Macrocheilia due to hyperplasia of the submucous, labial, salivary glands.

CASE 2 B. L. (New York Hospital Case No. 169560) This patient was a 28 year old Jewish housewife, mother of 2 children, who presented herself for treatment for the first time in May, 1937. A year before admission she awakened one morning to find her upper lip intensely swollen. There was no known related cause. The swelling increased for the next 2 months and then during a 4 month period decreased somewhat but the lip did not return to normal size. For 6 months prior to admission to the hospital, the patient had attacks of vertigo, chills, hot flashes, occurring at about 3 week intervals and always followed by an increase in the degree of swelling of the lip. In about 12 hours the swelling would reach its maximum and thereafter for 7 to 8 days it would decrease until the next cycle started. Menstruation ceased in 1936 following the birth of her last child.

Seven years before admission to the hospital and again 6 years before admission the patient described what apparently was a paralysis of the left side of the face, evidenced by inability to close the left eye or to use the facial muscles on both occasions. There was no history of idiosyncrasy to food or drugs. Patient had not used lipstick in 7 months. Several times leeches had been applied to the lip in unsuccessful efforts to reduce the swelling. The appearance of the patient before the onset of the deformity is shown in Figure 7.

When the patient was presented at the plastic surgery clinic of the New York Hospital, facial examination showed a diffuse swelling of the upper lip (Figs. 8 and 9). The en-



Fig. 1. Reproduction of drawing of specimen and microscopic field from Fraenkel's case of macrocheilia due to "adenomatous tumor" of the labial salivary glands.

largement caused ectropion of the mucous membrane and allowed the upper lip to protrude in unsightly fashion. The swelling was not compressible. There was no pitting of the skin and there were no varicosities over the surface of the lip. The lip was not tender. There was no bruise. Close inspection of the mucosa of the lip showed the presence of numerous submucous yellowish white nodules varying in size from 1 millimeter to 1 centimeter. The lip felt "shotty." Lowering of the head caused no increase in the swelling. Inspection of the mouth showed that the tongue was larger than normal and its surface presented the furrowed appearance of the geographic tongue. The teeth were in good condition. There was no evidence of disease of the paranasal sinuses. General physical examination revealed nothing remarkable. Blood count showed white blood cells, 9,400, hemoglobin 104 per cent. Kline exclusion and Kline diagnostic tests were negative. Differential blood count: adult polymorphonuclears, 35 per cent; immature polymorphonuclears, 32 per cent; lymphocytes, 33 per cent.

Operation and result. On May 25, 1937, the patient was operated upon under colonic ether anesthesia. The lip was



Fig 2

Fig 2 Case 1 Front view Enlargement of upper lip of 6 years duration No variation in size of swelling No trauma



Fig 3

Fig 3 Case 1 Pre-operative profile



Fig 4

Fig 4 Case 1 Postoperative front view



Fig 5

Fig 5 Case 1 Postoperative profile

reduced to approximately normal size by the excision of a transversely placed elliptical wedge of mucous membrane submucous glandular tissue and adjacent hypertrophied musculature of the orbicularis oris muscle (Fig 1c). Profuse bleeding was controlled with ligatures of triple plain catgut. Edges of the wound were approximated with on end mattress sutures of fine silk. Twenty four hours after operation the patient had a violent chill and the temperature rose to 40 degrees C (rectal). A blood culture taken at this time showed no growth. Over a period of 4 days the temperature dropped slowly to normal. It was a full month after operation before the postoperative edema subsided completely. The cosmetic result as shown in Figures 10 and 11 was maintained for 6 months after operation. At that time the patient again experienced a mild chill vertigo and fever after which moderate swelling of the lip was again in evidence. A normal menstrual period followed (after an 18 month period of amenorrhea) and the lip returned to normal size. Two subsequent menstrual periods have occurred to date without recurrence of the symptoms or of the swelling of the lip.

Pathology The microscopic section of tissue removed by biopsy preliminary to the plastic operation showed

hypertrophied labial mucous glands which were increased in number. In addition there was evidence of acute inflammation. They showed no evidence of malignant change and were contained in a fibrous tissue stroma. Examination of the specimen removed at operation is described by Dr N. C. Foot as follows: Sections through the lip show a very marked hypertrophy of the mucous glands which are increased in number and show complete structure with ducts. Just beneath the mucosa there is a diffuse inflammation of the submucous tissue in which numerous tubercles are present with giant cells epithelioid cells and lymphocytes. This has the appearance of a rather diffuse sarcoid. Tubercle bacillus stains show numerous diplococci and other bacteria but tubercle bacilli as such are not found. There are large numbers of mast cells. The lesion then has some resemblance to that of lupus vulgaris grafted upon the glandular hyperplasia already noted. Other sections show extensive inflammatory reactions probably secondary to biopsy. Ictomicrograph is shown in Figure 12.

Diagnosis Macrocheilia due to hypertrophy and hyperplasia of the labial salivary glands in association with non specific cheilitis.

From the viewpoint of the clinician these findings in microscopy in association with the unusual postoperative febrile reaction the transient facial palsy (most probably inflammatory), and the intermittent increase in size of the swelling of the lip before operation gave evidence of the fact that in addition to the hypertrophy and hyperplasia of the labial salivary glands, there was also present some degree of non specific cheilitis.

CASE 3 M. I. (Case of Dr W. DeW. Andrews.) A 33 year old white woman presented herself for correction of a deformity of the upper lip which had been noticed for the first time following an injury (fall down the stairs) sustained 25 years earlier. The enlargement had persisted without variation in size. There was no history of facial paralysis. In childhood the patient had measles mumps whooping cough and chicken pox. There was no history of disease of the paranasal sinuses and no evidence of allergic disease. The history was otherwise irrelevant. Patient desired operative correction of deformity for its cosmetic effect.

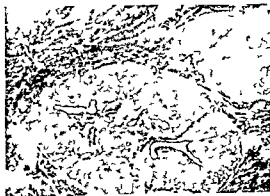


Fig 6 Case 1 Low power photomicrograph of tissue removed from the lip. Normal structures were distorted by the presence of the hyperplastic labial salivary glands.



Fig 7



Fig 8



Fig 9.



Fig 10



Fig 11.

Fig 7 Case 2 Photograph of patient taken before the occurrence of the deforming enlargement of the upper lip

Fig 8 Case 2 Pre-operative front view showing the enlargement of the upper lip The swelling increased periodically and on two occasions there was transient facial paralysis

Fig 9 Case 2 Pre-operative profile showing the excessive enlargement of the upper lip

Fig 10 Case 2 Postoperative front view showing the condition of the lip 6 months after plastic operation.

Fig 11 Case 2 Postoperative profile taken 6 months after plastic operation

Physical examination showed diffuse enlargement of the upper lip with a transverse furrow which was most pronounced when smiling or laughing This conformed to the description in the German literature under the term "double-lip" There was indentation in the mucous membrane at the point of attachment of the frenum Palpation of the lip revealed that the enlargement was not due to edema and it was not compressible No varicosities were in evidence No bruit could be heard over the swelling Lowering of the head did not cause an increase in the size of the lip On digital pressure the lip felt nodular There were no ulcerations, fissures, or fistulas Examination of the neck revealed no enlargement of the cervical glands or of the thyroid gland There was no evidence of disease of the nasal sinuses and the teeth were in good condition The remainder of the physical examination was negative Laboratory data white blood cells, 9,450, hemoglobin, 90 per cent, blood, Kline, negative, Wassermann, negative Photograph of patient is shown in Figure 13

Operation and result On August 4, 1934, Dr Andrus excised an elliptical segment of mucous membrane and underlying tissues approximately 3 by 1 centimeters in size from the right upper lip and a similar segment from the left upper lip The wounds were closed with interrupted sutures of catgut After operation there was moderate swelling of the lip This receded to normal in 10 days

Pathology Gross examination of the specimen showed hyperplasia of the submucous tissue There was no tendency toward encapsulation of the hyperplastic tissue Microscopic examination showed excessive hypertrophy of the submucous salivary glands These tended to arrange themselves in small nodules as shown in Figure 14 The cells were both serous and mucous in type There was an increase in fibrous tissue

Diagnosis Macrocheilia due to hyperplasia of the submucous salivary glands with "double-lip" formation

Three years later the patient reported for examination because of a recurrent swelling on the right side of the upper

lip In the interim there had been no swelling Examination showed that a nodule 1 centimeter in diameter was present in the line of closure on the mucosal side of the lip It was punctured and saliva exuded A small fistula remained Photograph of the patient at that time showed that a suggestion of "double-lip" formation was still present At a second operation the excess labial tissue was excised Microscopic examination of the tissue removed showed a picture similar to that described The patient has remained well to the present date, 5 months after the second operation

After a careful review of 129 cases of macrocheilia collected from the literature and a personal



Fig 12 Case 2 Low power photomicrograph Tissue adjacent to hyperplastic labial salivary glands shows much evidence of chronic and subacute inflammation



Fig 13 Case 3 Front view showing the double lip formation of the upper lip apparent on laughing

study of 3 additional cases, it is strikingly apparent that the etiological factor in this local alteration of the labial salivary glands has not been determined. Because the enlargement of the lip was present in some cases from early childhood certain authors have held to the theory that the abnormal enlargement of the lip is congenital in origin. The underdevelopment of the upper jaw as a cause of over activity of the under lip with consequent stimulation of the mucous glands as observed by one author has been not regularly noted by others. The presence of mucous fistulas with associated infection (cheilitis) in certain



Fig 15 Technique of cheiloplasty. Artist's sketch showing the outline of incision on the mucous membrane side of the lip through which a wedge shaped section of the hyperplastic glandular tissue is excised.



Fig 14 Case 3 Low power photomicrograph of tissue removed from the upper lip at operation. Note the hypertrophy and hyperplasia of the labial salivary glands.

cases has given rise to argument for the infectious nature of the disease. In none of these cases was the bacteriological examination adequate. Regarding specific infection many of the later case records state that serological tests for syphilis were negative. In the earlier cases in which the patient exhibited clinical signs of syphilis at the same time that the lip was enlarged, there is no conclusive evidence that the macrocheilia was a manifestation of that disease. A few of the descriptions of cases associate the onset of the enlargement with an antecedent trauma. The vast majority, however, do not give a history of injury and the evidence, on the whole, is against previous trauma as a causal factor in hyperplasia of the submucous glands. That the hyperplastic condition of the labial salivary glands is not neoplastic in origin is favored by the fact that not one of the cases has shown true tumor formation although many of them have been recorded as adenomas. The formation of adenoma in the submucous glands of the lip appears improbable because of the rare occurrence of true adenomas in the major salivary glands, namely the parotid, the submaxillary and the sublingual. The occasional reports of adenoma of these glands have always excited academic discussion as to whether or not the tumor was a true adenoma or a mixed tumor. On the basis of a few reports of hypertrophy of the labial salivary glands in association with carcinoma of the lip, it has been suggested that the condition is precancerous. This belief is not strengthened by this study.

Regarding therapy, it may be stated that surgical excision has given highly satisfactory results. Radium therapy, x-ray therapy, and injections of

boiling water have been suggested. Adequate follow-up notes are not available on the cases in which these methods have been used

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Fig 13 Case 3 Front view showing the 'double lip' formation of the upper lip apparent on laughing

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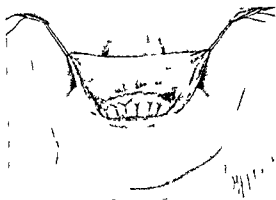


Fig 15 Technique of cheiloplasty. Artist's sketch showing the outline of incision on the mucous membrane side of the lip through which a wedge shaped section of the hyperplastic glandular tissue is excised



Fig 14 Case 3 Low power photomicrograph of tissue removed from the upper lip at operation. Note the hypertrophy and hyperplasia of the labial salivary glands

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Regarding therapy, it may be stated that surgical excision has given highly satisfactory results. Radium therapy, x-ray therapy, and injections of

high percentage of acute sprains are secondary to an insufficiency.

The functional decompensation of the back is associated with so called poor posture which means an increase of all the normal curves and a shifting forward of the body center of gravity. If the rounded dorsal kyphosis has been of long standing there is a tendency to fixation in this area, this fixation must be broken down and the abnormal curvature corrected.

The principle by which this correction is accomplished is based on the fact that 80 per cent of the motion of the spine is in the lumbar area which is mobile. With the patient bending forward, a body jacket is applied to fix the pelvis and the lumbar area. Any correction that occurs must, of necessity, be above the cast and in the dorsal area. The body-righting reflex automatically requires the patient to correct the rounded dorsal kyphosis (4). The bending forward plus overhead extension by means of a Sayre head-piece, tends to decrease the lumbar curve, this correction is retained since the cast is applied in an over-corrected position.

The technique by which this method is carried out is as follows: The patient is fastened to a crossbar on a vertical frame and the head-piece adjusted so that a satisfactory overcorrected position is established, the patient is tied to the crossbar and the Sayre extension is fixed so the position is retained until the cast can be applied (see photographs). The average cast requires eight rolls of fast-setting, 6-inch orthoplast plaster. After the cast is applied it is trimmed above and below, above, so that the cast comes to about the tenth dorsal vertebra in the back and slightly above the umbilicus in front, and below, so the patient can sit comfortably and is able to lace his shoes. To correct the deformity completely it is sometimes necessary to change the cast as many as three or even four times, occasionally a single cast is all that is required. The length of time that the cast is worn is determined by the rapidity with which the correction is accomplished. The recognition of correction is very simple since the cast becomes too loose and the patient pulls out of it. It is obvious that the cast does not change, therefore, the patient must have changed, and the change—if the position were correct—necessarily, will be in the nature of a correction of the deformity.

It is necessary not only to correct the deformity and protect the back against further irritation, which is accomplished by the cast, but it is also essential to re-establish the normal capacity of the back. When the cast has been applied, strain can

no longer occur in the lumbosacral or sacro-iliac areas; the weight is transmitted from the dorsal area onto the pelvis by means of the cast. This protection permits the inflammation to subside even though the patient is up and about. A proof that this actually occurs is the frequency with which patients who have had low back pain for years are relieved immediately upon application of the cast.

To increase the capacity of the back it is essential that the structures have normal exercise, without strain. We have already learned how the cast protects against the strain. Since the cast ends in the lumbar area it is possible for the patient to pull himself up so that the cast does not support him. This stretching is the primary functional exercise. In addition, a system of exercises is prescribed with this fundamental principle as the basis (3). These exercises are supervised so that they are carried out with accuracy. As the muscle control and strength of the patient increase, more exercises are added, the exercises must always be practical. Since there is a general fatigue present in cases of functional insufficiency of the back, periodic rest is prescribed. This is done to avoid chronic strain and means that the patient lies down in any position he desires (he may read or listen to the radio) for from 10 to 30 minutes every 2 to 8 hours, depending upon the need of the individual. After each rest period the patient carries out the exercises. As soon as it is physically possible, sports are permitted. Frequently it is possible for the patient to play golf or tennis while the cast is being worn.

The secondary deformities are automatically corrected by means of the cast and exercises. The costal angle is increased, the lung expansion is enhanced, which means an increase of vital capacity, the pendulous abdomen disappears as soon as the muscles become strong enough to hold the abdomen flat, which results in a decrease of the waistline. Often the waistline decreases as much as 5 inches during the course of treatment, which is very gratifying to the patients, particularly the women. The association of weak feet and pes valgo planus with the functional decompensation is very frequent. Corrective shoes are prescribed and correct gait is taught, which means holding the erect position of the body and walking with the rolling gait.

Very frequently the fatigue is due, at least in part, to malnutrition; this phase is studied and proper diet and tonics are prescribed. In consideration of Schanz's findings of osteoporosis of the vertebrae in cases of functional decompensation, it has been customary to prescribe calcium

THE TREATMENT OF LOW BACK PAIN DUE TO FUNCTIONAL DECOMPENSATION

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FUNCTIONAL decompensation is an imbalance between the capacity of the structures of the back and the physiological demands made upon them (1). A decompensation implies an insufficiency of structure and resultant disability. Just as cardiac decompensation does, so a decompensation of the back gives rise to certain symptoms and findings.

The symptoms are low back pain and tiredness, this fatigue of the back is often associated with a general fatigue. The primary symptom, however is pain which is variable in character. The first pain noted is usually generalized and is in the muscles, with associated stiffness on arising after rest. Later the pain localizes and may involve the lumbosacral angle or the sacro-iliac joint. The interpretation is that the ligaments have been stretched and are inflamed. If the condition persists the joint becomes inflamed and a true arthritis develops.

The objective findings in decompensation of the back are impaired muscle tone and an increase of the normal curvatures of the spine, with tenderness over the lumbosacral and sacro-iliac areas. This means poor posture, a rounded dorsal kyphosis and increased lumbar lordosis and in extreme cases a right dorsal and left lateral lumbar curvature. The abdominal muscles are weak and the abdomen sags. In the acute phase of this condition there is a sudden catch associated with lumbar muscle spasm, loss of the lumbar curve, a protective list with a pelvic tilt, and limitation of motion in the lumbar area. Associated with this condition we frequently find a low blood pressure, secondary anemia, nutritional deficiency and a low metabolic rate. These are, in reality, causative factors. Sciatica is a frequent complication, explained on the basis of repeated stimuli caused by strain together with a low nervous threshold due to fatigue. In other words, a neuralgia (2).

The essential pathological change is an inflammation in the region of the lumbosacral angle and the sacro-iliac joints. The alteration in posture is secondary to a functional decompensation which, after all, is the basis of the entire symptom complex.

TREATMENT

The treatment consists first, in relieving the inflammation, second in correcting the deformity and third in re-establishing normal capacity. The acute inflammation caused by a sudden strain requires immediate bed rest, if it occurs during the course of the individual's occupation, he is advised to lie down until the muscle spasm relaxes. As soon as the acute spasm has subsided sufficiently, the patient is either strapped with adhesive or hospitalized. He is allowed to lie in the position he finds most comfortable which is usually on the back with a small soft pillow in the lumbar area and the knees flexed. The amount of rest required depends upon the severity of the injury to the ligaments, a criterion to guide the surgeon is the rapidity with which the muscle spasm subsides, this varies from 12 hours to 10 days. If the patient is treated immediately after the injury, the usual time required is about 3 days. With the subsidence of the muscle spasm there is relief from the pain, the ligaments, however, are still far from healed. It is necessary further to protect the back in order to permit the patient to be up and about. The most simple method in order to accomplish this is to fix the lumbosacral and sacro-iliac areas with adhesive strapping.

The technique for proper strapping is to have the patient stand facing a table or desk, assuming the tallest attitude possible, with the abdominal muscles contracted, and to run strips of 2 inch adhesive from below the greater trochanter on one side to above the anterior sacro-iliac spine on the other side. Horizontal strips are then applied from the sacrum well up into the lumbar area. This retains a fixation and at the same time insures correct carriage. The adhesive is worn for 3 to 5 days when it is reinforced, since it tends to loosen. After from 7 to 10 days it may be necessary to restrap entirely the lumbosacral area. The back should be protected for from 10 to 21 days. The patient in the meantime is permitted to be about. If no previous functional insufficiency has been present he will be able to continue with his usual work and obtain a complete recovery. Since a functional insufficiency of the back predisposes to these acute attacks, a very

overstrain. These strains, however, subside promptly after a short rest period. The exercises are then carried out as usual. It is advisable to observe the patient at intervals of from 1 to 3 weeks to guard against strains and to encourage exercises until the maximum capacity of the back has been reached. Once normal capacity has been re-established, the patient no longer has any symptoms of backache while carrying on his normal occupation, without wearing a support. Not only has the backache been relieved during the course of treatment but the fatigue syndrome has also been lessened.

This treatment has been successfully carried out over a period of about 10 years. The primary objective of the treatment is relief of the backache and the secondary neuralgias, but just as important to the patient are the relief of the fatigue syndrome, the re-establishment of a normal outlook, and the improvement in appearance. In other words, the disability is cured and the deformity corrected.

To demonstrate these principles of treatment, I wish to cite 5 cases:

CASE 1 Miss N H, 34 years of age, a school teacher, complained of nervousness, intermittent lumbago and low backache which had been present for 4 years, she was irritable, worried, and tired all the time, her back felt stiff on getting up, the pain was worse after prolonged sitting or standing, she obtained relief by lying down. For 5 months before she was seen she had had pain down the lateral side of the right thigh and leg, which had become worse until finally she was unable to walk. Relief was obtained only by constant rest and continued local heat.

At examination it was evident that she was suffering pain, she could not stand erect, any attempt at motion in the lumbar spine caused pain. There was a definite list to the left and slight atrophy of the right thigh and leg, there was lumbar muscle spasm, and the Lasègue sign was positive. The blood count and urine were normal, the blood Wassermann was negative. Roentgenogram of the lumbosacral area showed no abnormal change. A diagnosis was made of muscular insufficiency of the back, sacro-iliac strain, and right sciatica.

The patient was admitted to Passavant Hospital and bilateral Buck's extension was applied with the knees in flexed position. Local heat (an electric pad) was applied to the back, and she was given 10 grains of salicylate three times a day. After 5 days the muscle spasm in the back was relieved and a lumbar curve re-established. A small pillow was applied in the lumbar area and the patient was allowed to turn over on her abdomen, hot packs were applied for one-half hour three times a day. By the eighth day the back was well relaxed and the pain had disappeared. A plaster-of-Paris cast was then applied in the upright frame. The slight discomfort noted during the first night after the cast was applied was not sufficient to interfere with her sleep, the following day she was able to stand and walk, holding herself erect, with comfort. Exercises were started immediately and increased on the fifth day following the application of the cast. She was then seen at weekly intervals, and each time the exercises were increased. She left the hospital 2 days after the cast was applied.

On the twelfth day she had improved to such an extent that the cast was loose and no longer giving any support, a new cast, taking more correction, was applied and exercises and periodic rest carried out as before. In the beginning she rested 20 minutes out of each hour, by the time the second cast was applied the rest periods were lessened to five a day. She wore the second cast for 3 weeks. At that time she had a full correction with normal curves in the spine but, as there was still some tenderness over the right sacro-iliac joint, a third cast was applied which held the corrected position for another 2 weeks, after which a fitted cloth and steel corset was worn for another 5 weeks. During this period the patient was entirely free of pain, but the capacity of the back and abdominal muscles was still below normal. At the end of 9 weeks complete relief had been obtained. She continued her exercises without observation and was next seen 1 year later, she had remained well during this entire period. Two years later she reported again, simply to say that she had had no further symptoms during the 3 years since her dismissal.

This case typifies the care of patients suffering with sciatica associated with low back pain due to muscular insufficiency of the back. The presence of nervous fatigue and the symptoms of muscular decompensation are characteristic for this group. The treatment consists in removal of the functional decompensation by the method described, and care of the nervous strain. The condition is explained to the patient, vitamins B and G are prescribed, and the social and economic problems are taken into consideration. There is a definite response to treatment.

CASE 2 Mrs H B, 26 years of age, a housewife, complained of pain in the lower part of the back, which had been present for over 10 years, worse after childbirth, very severe after birth of her second baby, she was exceedingly tired all the time, the backache had been continuous for 2 years with periodic exacerbations. A diagnosis of right sciatica had been made following her first pregnancy, this pain in the right thigh had recurred periodically ever since. She had had trouble with her feet, slightly relieved by the wearing of stiff-shanked shoes, she had had some osteopathic treatment. Her general health was excellent.

Examination showed an intelligent young woman with a rounded kyphosis in the dorsal area and a slight right dorsal scoliosis, the lumbar curve was increased and the abdomen tended to sag, the muscle tone in the extremities was good but the abdominal and back muscles were weak. A diagnosis of muscular insufficiency of the back with sacro-iliac strain and right sciatica was made.

The back was strapped with adhesive as a test, on the third day she returned stating that she had had more relief than she had had for 3 years. The following day the adhesive was removed and a plaster-of-Paris jacket applied, this gave her immediate relief. Exercises were started at once. After 10 days the cast was cut to the level of the twelfth dorsal vertebra in back. The dorsal curve showed correction. She used a sand-bag and the exercises already described, these were gradually increased. After 2 weeks the cast was so loose that it no longer gave support, a new cast was applied, at which time her back was found to be in normal position. She continued her exercises and wore corrective shoes. At the same time the periodic rest which was started at the onset of treatment was decreased from 20 minutes every 2 hours to three rest periods of 20 minutes

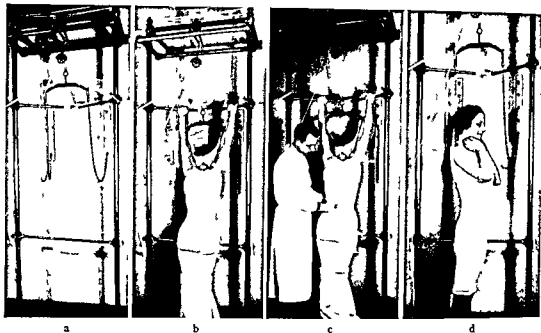


Fig 1 a Modified Haglund frame b Patient in position of correction of frame c Modeling cast d Lateral view of finished cast.

gluconate and dicalcium phosphate together with viosterol. When the deficiency is definite large doses are used. Anemia and low hemoglobin are counteracted by means of lextron or ferrous

sulphate. For the convenience of the patient who is carrying out his normal occupation wherever possible, the tonics are prescribed in the form of capsules or tablets. When the nervous fatigue is great, vitamins B and G are prescribed. The low metabolic rate usually rises automatically as the fatigue decreases. The discriminate use of Lugol's solution has been found more effective than the thyroid extract which has been so frequently prescribed in these cases.

The cast is worn until the correction is attained. The normal position is held with the last cast for a period of from 10 days to 4 weeks depending upon the length of time the condition had been present before treatment was instituted. After removal of the cast, a corset is worn during the day to guard against strain the corset is worn whenever prolonged sitting is necessary it is advised particularly for those who earn their living by riding in a car. The exercises and periodic rest are continued until the capacity is sufficient to carry out all the requirements of the individual, which is usually about 3 months.

The re establishment of capacity in the back prevents recurrences. During the process of re establishing normal strength as one might expect acute attacks occasionally recur. In the desire to increase strength rapidly the individual may



Fig 2 a Anterior view of finished cast b Posterior view of finished cast c Patient dressed wearing cast

little prominent, and a third cast was applied, this he wore for 2 weeks. He was then put into a form-fitting corset; he took a vacation, continued his exercises, began to play golf again, and took up swimming, gradually he left off his support. He has continued to feel well for a period of about a year.

This is an example of static arthritis, secondary to mechanical strain, in older patients. The treatment is practical in that even a man of 57 years does not find it too strenuous. This patient felt that his general improvement justified the treatment. The back pain and sciatica disappeared with the cure of the decompensation.

CASE 5. Mr J. R. W., 32 years of age, a gas-house foreman, in 1931 he had twisted his back and noted sharp pain, his physician made a diagnosis of lumbago and wrenched back and treated him, with some benefit, at intervals since then he has awakened mornings with a tightness in the back, and has had recurrent sharp attacks, lasting from 2 to 3 days, attacks gradually became more frequent and more severe until finally he had a constant backache while at work, 6 months before he was seen his legs had begun to ache, he felt tired all the time. He had been examined and treated for sacro-iliac arthritis, definitely shown by the x-ray. Chronically infected tonsils and several infected teeth had been removed, he had been given salicylates and tonics—all without relief.

Examination showed an increase of all normal curves, lumbar muscle spasm, tenderness over the lumbosacral angle and in the sacro-iliac area. A diagnosis was made of muscular insufficiency of the back with sacro-iliac strain.

Treatment was started immediately. A plaster-of-Paris cast was applied and he obtained immediate relief. He continued to work while wearing the cast, resting at noon and again immediately after work, he carried out his exercises after these periodic rests. In addition he was given corrective shoes and taught the normal gait, a sandbag was used to get proper posture. After 2 weeks the cast was changed. He lost no time from his work and had no further pain after the application of the first cast. He continued to gain strength, the capacity of the back improved so that the cast was lowered each week. The second cast was worn for 3 weeks, after which he was fitted with a corset. He was also given calcium gluconate and viosterol.

He has remained well for more than a year. He has no backache and no feeling of fatigue, and he states that he has not felt so well in 5 years.

This case is typical of a group of adults who are dependent on hard labor for earning their living. Though of long standing and recalcitrant to medical treatment, the response to measures directed against the functional decompensation was

immediate. The treatment was executed with the patient ambulant and able to do his work.

CONCLUSIONS

1 Functional decompensation of the back (an imbalance between the capacity of the back and the load or the work demanded of it) is a very common cause of low back pain.

2 Anything that increases the demand or decreases the capacity of the back is, therefore, a causative factor.

3 The backache is primarily due to an inflammation at the lumbosacral angle and sacro-iliac joints.

4 The treatment consists first, in relieving the inflammation by proper adhesive strapping of the back, second, in re-establishing normal posture by the application of a corrective or active plaster-of-Paris cast, and third, in re-establishing the normal capacity of the back by means of a system of practical exercises.

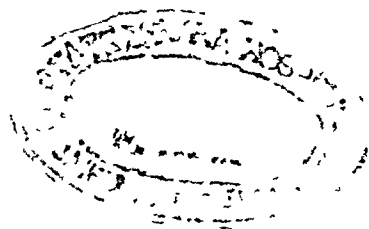
5 Dietary deficiencies frequently cause a decrease in physical capacity. These deficiencies are evaluated by the attending physician who outlines a proper diet, viosterol and calcium are useful in bringing about a restoration.

6 Anemia, which is frequently present, is treated with liver extract (Iextron) and iron (ferrous sulphate). Nervous fatigue is combated by means of vitamins B and G.

7 Low back pain is, thus, frequently a part of a general condition and is treated accordingly.

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each daily. Four weeks later the cast was removed and she was fitted with a corset.

During this entire period she had had no pain in the thigh. The backache was relieved but did recur after severe strain incident to the care of her sick child lasting about 1 week. *She has been well ever since. She is able to play tennis and golf and carry out her usual duties. She gained three-fourths of an inch in height. The dorsal kyphosis which had been present since her adolescence was entirely relieved. For the first time her posture was satisfactory to herself and to her parents. The abdomen was flat and her hip measurement was 2 inches less than before treatment. She is no longer fatigued but energetic and active.*

This case is characteristic of a group of neglected adolescent scolioses who develop a functional decompensation as young adults or in later life. The cure of the functional decompensation relieves the symptoms of which the patient complains and corrects the deformity present.

CASE 3. Mrs. C. D., 38 years of age, a housewife, complained of backache which had been present for 10 years worse after the birth of her only child. She was awakened mornings by the pain in her back which increased after driving a car or sitting in a chair. Back felt stiff on arising, pain worse with change of weather. She was tired most of the time. She was an active woman but because of her backache was unable to do the things she liked to do and had gained about 10 pounds in weight. During the last few months before she was seen she had had pain in the lower extremities limited to the thighs. Sometimes one thigh was involved sometimes the other never both at the same time. She had obtained some relief from lying in the sun and the backache had subsided while she was in bed following an operation. She had received various types of medical care including salicylates, bed rest and heat. She had been placed on a Bradford frame and had worn a belt—all with out relief. She did obtain relief during her rest periods but on getting up again the back seemed worse than before. Orthopedists had advised a fusion operation.

At examination the back showed an increased rounded dorsal kyphosis, an increased lumbar lordosis, sacro iliac tenderness on both sides and tenderness over the lumbo sacral angle. X-ray examination of the lumbar spine was negative. The abdomen sagged and she had gained weight especially about the thighs. The costal angle was narrow. She walked with a shuffling gait and had a facial expression of fatigue and strain.

She entered the hospital for 2 days for a general examination. During this time hot packs were applied three times a day. On the third day a body jacket was applied which gave prompt relief. General exercises were started and gradually increased in the usual manner. She was given corrective shoes and taught the normal gait. On the second day after the cast was applied she was permitted to return home—an overnight journey.

When seen 2 weeks later the cast was loose. She had already obtained a great deal of correction in the dorsal area. A new cast was applied with further correction of position. Viosterol 15 drops and calcium gluconate 7½ grains three times a day were prescribed. She felt very much better.

Two weeks later the cast was trimmed and made lower. Periodic rest was continued. She still had some pain at the lumbosacral angle particularly after strain or prolonged sitting.

After another 2 weeks a third cast was applied. The position of the back was then entirely corrected and the new

cast applied in the overcorrected position. This gave complete relief. She continued her exercises, began taking walks and playing tennis.

Four months after the institution of treatment the third cast was removed and a satisfactory corset fitted. Her general condition was very good. She had lost 1 inch in hip measurement and had gained about 1¼ inches in height. The costal angle was broader and she no longer felt fatigued. Her backache had entirely disappeared. For a period of 2 months however she had to guard against prolonged sitting particularly riding in a car which would cause some stiffness in the morning on arising. She has now been entirely well for a period of 6 months.

This case is typical of a group of cases in which the condition was of long standing and in which medical care and orthopedic measures had been attempted until finally a fusion operation had been advised. The immediate response to treatment in the way of relief of symptoms even though of long standing was striking. With relief of the backache the general health of the patient is improved, the functional capacity is increased, they have a feeling of well being and in many instances the blood pressure and the metabolic rate are increased, as is also the vital capacity.

CASE 4. Mr. D. J. M., 57 years of age, a retired business man, complained of pain in the right lower extremity and lower part of the back which had been present for over a year. He first noticed a constant fatigue so marked that everything he did was an effort. He decided to take a vacation and play golf. Enroute to Florida he developed pain in the right sacro iliac area and right thigh which became progressively worse and radiated down along the knee and into the calf. Pain was worse when riding in a car, playing golf or walking over rough ground. He obtained some relief by lying in the sun in the warm sand on the beach but on his return home the pain continued. He was stiff on arising in the morning and was unable to play golf. His general fatigue, the pain in the back and the nagging pain in the sciatic region continued to get worse and he consulted a physician for a general examination. Several teeth were extracted and a tonsillectomy done without improvement. He had his shoes made by a special shoemaker.

Examination showed an elderly man definitely overweight with a pendulous abdomen. The abdominal muscles had very poor tone so that he could draw the abdomen up only slightly. He wore an abdominal support. There was marked valgus at the ankle and at the knee and pronation of both feet. X-rays showed slight hypertrophic arthritis in the lumbar area. A diagnosis of muscular insufficiency of the back with sacro iliac strain and pes valgo planus with foot strain was made.

His back was strapped with adhesive and his shoes padded. He obtained immediate relief. Two days later he returned eager to carry out further treatment. The adhesive strapping was removed and a plaster-of-Paris cast was applied with corrected position. The following day the cast was trimmed. Two days later he stated that he was comfortable and had no backache. Exercises were started. He was given corrective shoes and taught the normal gait. When seen 10 days after the application of the second cast, he had gained a great deal of correction and was delighted with his improvement. He stated that he had not felt so well in years. After he had worn the second cast for 2 weeks his posture was satisfactory but the abdomen was still a

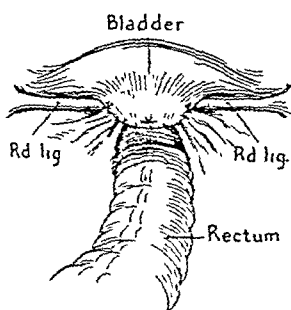


Fig 3

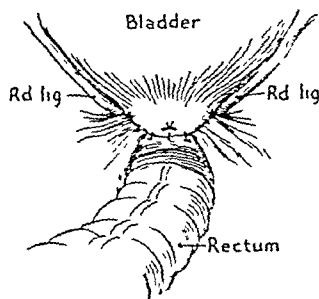


Fig 4

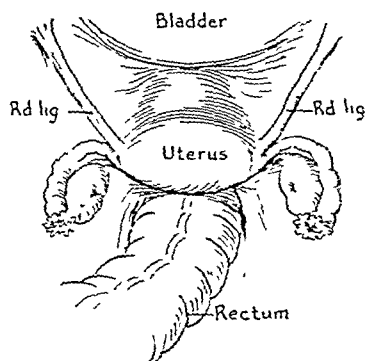


Fig 5

Fig 3 Pentonealization finished. The cervix is elevated 1 to 1½ inches, and to that extent the vaginal wall, including the rectocele and cystocele, is elevated. On account of the difficulty of illustrating the actual elevation of the vaginal wall, this phase of the operation is left to the imagination.

Fig 4 (Old technique) The round ligament pedicles are brought down to prolapsed cervix. Position of vaginal wall, including cystocele and rectocele, remains unchanged.

Fig 5 (Old technique) It shows the round ligaments long and relaxed and the uterus retroverted and prolapsed. In procidentia the uterus is as a rule retroverted.

6 other cases about 1/5 of the original cystocele would still come down on straining. This is undoubtedly due to the uterus not having been amputated low enough. But we get such degree and percentage of failures even after cystocele operations. Of rectoceles it was mostly successful in cases associated with prolapse or sagging of the posterior vaginal wall. Judging from results obtained, it seems that there is sagging of the anterior vaginal wall in all such cases and of the posterior wall to the extent of a varying fraction.

In those conditions in which supravaginal hysterectomy (without procidentia) is indicated, but in the presence of cystocele and rectocele, I obtain a preknowledge as to results and indication for operation on the latter, as follows.

I hook a tenaculum on the anterior lip of the cervix, through a speculum. I then remove the speculum and elevate the uterus by pushing up on the tenaculum. Now I ask the patient to bear down. If the cystocele and rectocele do not come down they can be left out of consideration, depending for their automatic correction on the

hysterectomy technique. Lately I employ a simpler test. I elevate the cervix with a dressing forceps holding a short tampon of cotton.

I am frequently told by men who have watched my technique and who concede that the vaginal wall is thus elevated, that they fail to see how the round ligaments could be depended upon for permanent support of the structures. The objection is unsound practically. First of all and foremost there is no longer present the large and heavy uterus with its overstretched supports (non-supports), which acts adversely by its own weight and upon which intra-abdominal pressure is directed. Second, the overlapping tense bridge removes any "sag" in the round ligaments as well as of the broad ligaments, the cervix, relatively light, is attached to the undersurface of the bridge, the attachment of the tubo-ovarian pedicles to the cervix and the peritonealization with the bladder fold covering all the superimposed structures on the cervix and beyond, form one consolidated, well distributed support, invincible to caprices of intra-abdominal pressure.

CORRECTION OF CYSTOCELE AND RECTOCELE IN THE PROCESS OF SUPRAVAGINAL HYSTERECTOMY

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THREE years ago I was confronted with a case of myomatous uterus in the third degree of procidentia with a cystocele and rectocele, the uterus being too large to be removed *per vaginam*. In addition the condition of the patient did not warrant an operation entailing the time necessary for the systematic correction of all the pathology present. I have accordingly devised a technique whereby the cystocele and rectocele would be automatically eliminated by a few modified steps in the technique of supravaginal hysterectomy.

After the round ligaments were ligated close to the uterus, and the rest of the steps completed the body of the uterus was severed from the cervix. A taut bridge was then formed of the round ligament pedicles by overlapping them as shown in Figure 1. This forms the cardinal step in the mechanism of the new technique. In the next step I elevated the stump of the cervix and attached it to the undersurface of the ligament bridge (Figs 1 and 2). This is in the reverse order of the usual technique in which the round liga-

From the Gynecological and Obstetrical Services, Beth David Hospital

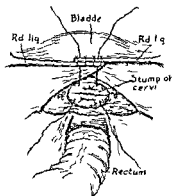


Fig 1 A perfectly horizontal taut bridge has been formed of the round ligament pedicles by 3 or 4 sutures placed and tied in a manner so that 1/2 of the long section of each pedicle remains free (circulation not obstructed). It also shows 2 sutures (more if necessary) passed through the bridge and the cervix as the first step in the elevation of the cervix to the undersurface of the bridge. It will be noticed that here likewise, the sutures are passed through the bridge with the view of guarding against obstruction of the round ligament circulation. As stated in the context

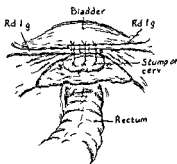
ment pedicles are attached loosely to the prolapsed cervix (Fig 4) and in which the vaginal wall and cystocele and rectocele maintain their status quo (Figs 4 and 5) unless repaired.

With the elevation of the cervix the vaginal wall, including the rectocele and cystocele came along to the extent of obliteration of the latter two. Peritonealization was carried out in the usual manner (Figs 3 and 4).

Since then I have had three other such cases which I have operated upon in the same technique with the same uniform good results. At the present time the cervix, in all these cases, is still on a high level and the rectocele and cystocele do not come down on straining.

The relaxed vagina, whether it be due to cystocele or rectocele or to prolapse or relaxation as a result of procidentia will be obliterated to the distance between the round ligament bridge and the location of the prolapsed cervix. And that usually is a distance of from 1 to 1 1/2 inches (compare Fig 1 as contrasted with Figs 4 and 5).

Encouraged by these results I proceeded to employ this method in all cases of supravaginal hysterectomy without procidentia, but with rectocele and cystocele. In 37 of 43 such cases the cystocele was corrected completely. In the



the round ligaments should be cut as closely as possible to the uterus and for two reasons: (a) if they are short a bridge cannot be formed; (b) the larger the pedicles are the more they will overlap each other thus enforcing the ultimate support against theoretical or probable ravages of the intra abdominal pressure.

Fig 2 Shows the cervix united to the undersurface of the bridge. Here the cervix does not appear to hug the round ligament snugly. This is done with the object of more clearly showing the steps of the technique.

The first step in attempting to remove a stone or foreign body from the common duct is to provide for the free egress of ductal contents into the duodenum. The lower end of the duct is guarded by the sphincter of Oddi which is probably associated with a pseudo-sphincteric action of the muscular fibers of the duodenal wall itself. At the American Medical Association meeting in 1936, we presented a paper (4) on cholangiography which proposed that nitroglycerin encouraged relaxation of the sphincter¹ and permitted the contrast medium to pass easily from the common duct to the duodenum. Also in 1936, Walters (9) and his group reported their experiments on common duct pressure as affected by spasm of the sphincter and the decrease in pressure afforded by both nitroglycerin and amyl nitrite. More recently, Doubilet and Colp have corroborated the effect of nitroglycerin. Our observations upon the spastic or non-relaxing effect of morphine certainly agree with those of Walters and Doubilet and Colp. The experiments of the latter two men also concur with ours in showing that atropine may relax or at least lessen the tension in this irritable sphincter area in some instances. We have previously reported upon the apparent soothing or relaxing effect of warm olive oil or iodized oil upon the choledochal side of the common duct sphincter when instilled through a T-tube or fistula. The effect of magnesium sulphate or fats such as olive oil or cream upon the duodenal surface has also been mentioned.

The second problem is to dislodge the foreign body by increasing the pressure behind it. If the stone or foreign body is below the T-tube, catheter, or fistula opening, this is easily accomplished by the injection of warm saline solution, olive oil or iodized oil through the tube or fistula.

It is also reasonable that increasing the flow of bile by stimulating its formation will augment the intraductal pressure. Neubauer in 1924 determined by experiments on animals and humans that sodium dehydrocholate, the sodium salt of dehydrocholic acid, increased the secretion of bile. We have, therefore, been experimenting with pressure changes effected by dehydrocholic acid, and Figure 1 is an example of increased intraductal pressure brought about by this means. The usual dosage has been 3 tablets (3¼ grain or 0.25 gram each) four times a day. A rise in pressure occurred in most instances, but there was considerable variation in the degree of change. At times it would increase 200 millimeters of water, while at other times a change of only 10 to 20 millimeters was apparent. We have also used the

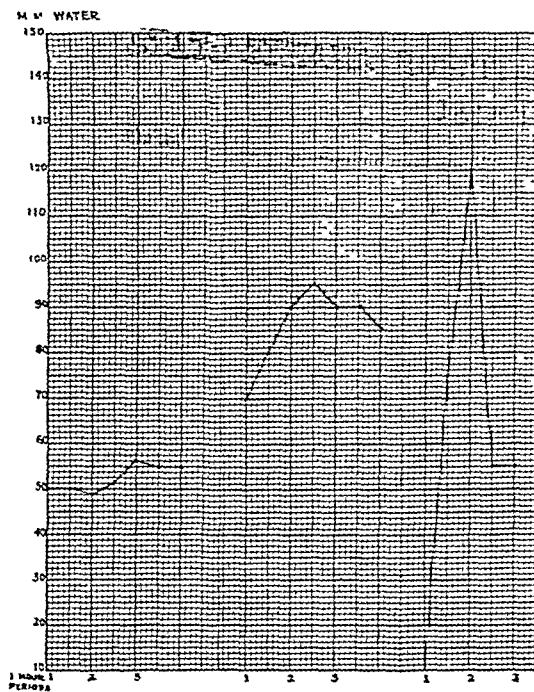


Fig 1 The general level of intraductal pressure during the administration of dehydrocholic acid is definitely higher than during control periods. With the intravenous injection of sodium dehydrocholate there was a sudden rise in intraductal pressure. Case A S cholecystostomy and choledochectomy.

sodium salt of this drug intravenously but do not feel that we have had sufficient experience as yet to advocate its routine use. This added pressure is of maximum value when the foreign body is below the T-tube or catheter inlet or when only a biliary fistula exists, as it tends to force the impediment through the sphincter during a momentary relaxation. The secretory pressure of the liver is said to lie between 200 and 300 millimeters of water while the sphincter resistance or breaking point is about 150 millimeters, but our experience with the breaking point in the postoperative case shows it to vary from 0 to 175 millimeters. Clamping the tube or lightly packing the fistulous tract may or may not be necessary. Our experience has not been sufficient to warrant a definite statement.

If a stone is lodged above the upper limb of the T-tube or tip of the catheter, it is necessary to remove the tube before the stone can pass to the lower end of the common duct. An increased pressure in the biliary ducts may also wash smaller stones down from the liver, as definitely proved in one of our cases.

The first case presented illustrates the pos-

¹ 1/100 grain tablet dissolved under the tongue

CHOLANGIOGRAPHIC DEMONSTRATION OF THE REMAINING COMMON DUCT STONE AND ITS NON-OPERATIVE MANAGEMENT

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SINCE adopting the rule several years ago of making delayed cholangiographic studies in all cases of common duct drainage or biliary fistulas, we have been able to prove, for ourselves at least, that thorough exploration of the common duct at operation by palpation, probing, scooping irrigation and suction does not always verify the presence of stones. If they are present and are not identified by palpation they may not always be removed by such measures. Also it is plausible that these remaining common duct stones may frequently be stones which have descended from the liver. This can be fully appreciated only by those who have investigated the postoperative status of the common duct through delayed cholangiography. If abdominal palpation alone were used as the basis of determining the frequency of cancer of the stomach, before it invades other organs the figures would be far amiss as x ray examination with the use of a contrast medium is essential. We believe that this holds true also with the remaining common duct stone. We all appreciate that patients not infrequently continue to have right upper quadrant distress after an apparently successful cholecystectomy. At times this has been proved due to spastic dysynergia of the sphincter of Oddi, or to cholangitis, pancreatitis or hepatic disturbances. That remaining stones, mucous plugs, blood clots, or organized debris within the intrahepatic or extrahepatic biliary ducts account for some of the postcholecystectomy syndromes has been forcibly brought to our attention by our experiences with cholangiography.

Just how frequently the common duct should be opened and explored is difficult to ascertain but no doubt it should be done more often than is commonly advocated. Lahey's statement that between 1910 and 1926 his group had opened the common ducts in 15.5 per cent of their gall bladder patients and had discovered stones in 8.4 per cent is illuminating. They gradually began to explore the common duct more frequently until be-

tween 1930 and 1931, of 138 patients operated upon 4.5 per cent were explored and stones were discovered in 21 per cent. It is noteworthy that approximately 50 per cent presented stones, regardless of the number of common ducts explored. It is also significant that 38 per cent of their patients with common duct stones were not jaundiced. Secondary attacks upon the common and hepatic ducts are not only difficult but hazardous resulting in a rather high mortality. Fully cognizant of these facts, we have attempted to dislodge remaining stones and other foreign bodies by various measures.

Our first attempts consisted merely in following the established method of irrigation through the T tube or catheter, with or without the use of atropine and morphine, alone or in combination. We feel confident that in the past smaller stones, mucous plugs or debris were not infrequently washed into the duodenum, thus obviating secondary attacks upon the biliary tract with their attendant mortality. After deriving more knowledge of the pathological physiology of the common duct from cholangiographic studies, a more scientific and practical attack was formulated.

That spasm of the sphincter of Oddi may exist is no longer a debated question. It has been proved by Westphal, Newman, Ivy and Sandblom, Saralegui and Best and Hicken, among others. This sphincter may be either in a completely relaxed, unrelaxed (achalasia) or spastic state (spastic dysynergia). The work of Meltzer and of Lyon in non surgical drainage of the gall bladder by means of tube and magnesium sulphate hypothesized the necessity of a relaxed sphincter of Oddi in order that bile might pass freely into the duodenum. The administration of fat (cream) by mouth in cholecystography to empty the gall bladder also suggests direct or indirect relaxation of the sphincter area to permit free drainage of bile into the duodenum. For years atropine has been considered efficacious in relaxing the sphincter, but recent studies have proved that it is variable and not to be entirely depended upon, although it should by no means be discarded.

From the Department of Surgery, University of Nebraska College of Medicine.
Presented at the meeting of the Western Surgical Association on Indianapolis, Indiana, December 3, 1937.

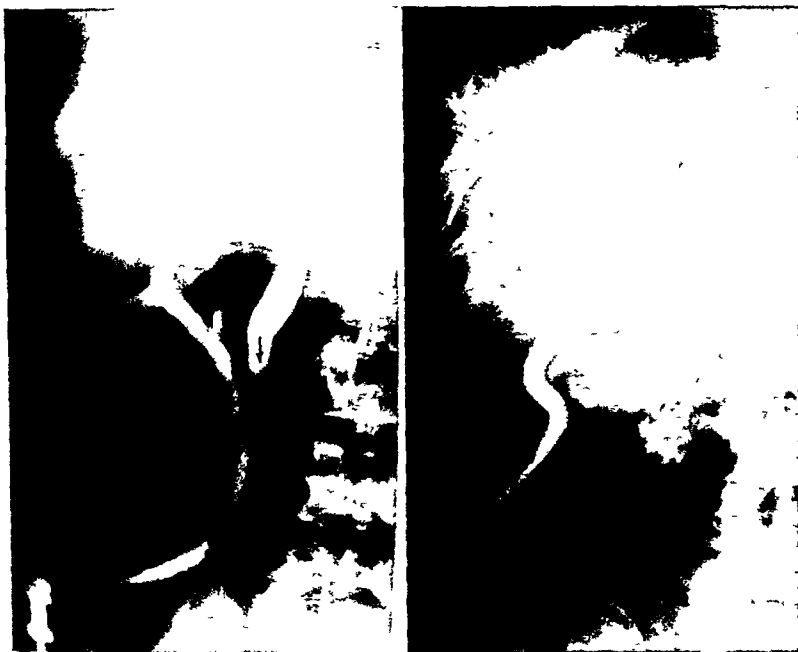


Fig 2 a, left. The cholangiogram reveals a stone lodged at the lower end of the common duct. There is an associated pancreatitis and the pancreatic duct is well visualized. b, The stone has been dislodged. Pancreatic duct still visible.

revealed no stones. A catheter was then placed in the common duct and the abdomen closed.

Cholangiogram. One week after operation a cholangiogram made with 20 cubic centimeters of hippuran solution revealed multiple stones in the common duct (Fig 3a). This was repeated several days later with the same picture.

As soon as the patient's condition warranted it, the previously described therapeutic measures were begun. After the first course of treatment, 10 stones were recovered from the stools. The cholangiogram was repeated and one stone was found remaining in the ampulla (Fig 3b). A second course of treatment resulted in passage of the 11th stone (Fig 4a). Two subsequent check-ups were negative. The fistula soon closed and now, 10 months later, the patient feels perfectly well.

We have been able to depict apparent foreign bodies in two other common ducts by postoperative cholangiograms, with defects irregular and inconstant in shape and position. It is highly possible they were small blood clots, mucous clumps, or lumps of inspissated bile which were dislodged (Fig 5). In any event, they disappeared under the described treatment. In a recent case, although none could be palpated, a very large stone was revealed in the common duct on the postoperative cholangiogram. Repeated efforts to dislodge it have been ineffectual and ether as advocated by Pribram has also failed to break it up (Fig. 6). We have also had a failure

with ether in an elderly woman with a gall-bladder fistula and cystic duct stone. However, from the report of Pribram, it is a method which has possibilities.

SUGGESTED TECHNIQUE FOR REMOVAL OF REMAINING COMMON DUCT STONES

When a stone or foreign body is identified in the common duct by delayed cholangiography, the following 3 day regimen is begun. On the first day a 1/100 grain tablet of nitroglycerin is dissolved under the tongue 3 times during the day; on the second, 1/100 grain of atropine is given 3 times, either by mouth or hypodermically, on the third day, the nitroglycerin is repeated. Each morning the patient is given 2 drams or more of magnesium sulphate in warm water and at bedtime, 1 ounce of olive oil (preferably) or thick cream. The common duct is gently irrigated every day through the drainage tube or fistula with warm normal saline solution, and after removing as much of this solution as possible with the syringe or by permitting the tube to drain for 5 minutes, 10 to 30 cubic centimeters of warm sterile olive oil are instilled. At times, lipiodine or lipiodol seems to exert a more beneficial effect. If the patient does not complain of distress, the tube

sibility of dislodging a stone from the common duct by this method after first permitting the edema in the sphincter area to subside

CASE 1 Mr O M aged 35 years had recurrent attacks of indigestion over a period of 16 months accompanied by pain in the upper abdomen nausea and vomiting Morphine was required for relief and upon one occasion he became slightly jaundiced The week before he entered the hospital he developed a severe pain in the upper abdomen which necessitated several hypodermics of morphine for relief and within 3 days he became icteric When examined the patient was very apprehensive definitely jaundiced and moderately tender over the gall bladder His icteric index was 75 the van den Bergh direct delayed reaction was moderately positive the stools contained bile his temperature was 99.8 degrees and he had a leucocytosis of 10 600 By conservative management the icteric index was brought down to 35 and after 5 days of observation and preparation the patient was operated upon with the diagnosis of cholecystitis cholelithiasis and common duct stone

First operation Under spinal anesthesia the gall bladder thick walled definitely inflamed and adherent to surrounding structures was removed The common duct was about twice normal size and was angulated at its junction with the cystic duct by inflammatory adhesions These were freed and the duct opened Thorough palpation probing scooping and irrigation revealed no stone The head of the pancreas was thickened and harder than normal A T tube was placed in the common duct for drainage purposes

Cholangiogram On the sixth day after operation a cholangiogram was made by injecting 20 cubic centimeters of hipuran solution into the common duct through the T tube No stone was visible but the sphincter appeared contracted This spasm was relaxed by dissolving 1/100 grain of nitroglycerin beneath his tongue The T tube was removed on the tenth day after operation following a check up cholangiogram which again revealed some sphincterismus but no stone The patient was discharged from the hospital a few days later with a remaining biliary fistula During the next 2 months he had continued attacks of chills fever upper abdominal distress and intermittent jaundice The sinus tract would close off only to reopen and drain pus and bile This occurred a number of times

Cholangiogram About 10 weeks after the first operation another cholangiogram with 30 cubic centimeters of hipuran solution revealed 2 stones in the common duct which had not been visible previously Operation was advised

Second operation An attempt was made to locate and move the stones from an enlarged common duct The head of the pancreas was also larger than normal quite hard and irregular as is consistent with marked chronic pancreatitis or new growth There was a pronounced inflammation around the common duct and duodenum The duct was explored as thoroughly as possible in the presence of this inflammatory reaction using finger probe scoop irrigation and suction but no stone could be palpated or dislodged The patient's unsatisfactory condition contra-indicated a transduodenal attack Therefore a T tube was hurriedly placed in the common duct and the abdomen was closed

Cholangiogram Because of digestion of the tissues around the wound a cholangiogram was not taken for 3 weeks at which time the picture was a little suggestive of a single stone in the region of the ampulla A recheck 4 weeks later definitely revealed a stone at the lower end of the common duct (Fig. 2a) The entire length of the pancreatic duct was easily visible

Cholangiogram The previously suggested regimen was immediately started and was repeated every 10 days In the intervals the duct was washed out on alternate days with sterile olive oil or lipiodine With each oil irrigation 1/100 grain of nitroglycerin was placed beneath the tongue After 1 month a follow up cholangiogram showed the stone still present but the opaque medium entered the duodenum more readily After a second month of treatment no evidence of a filling defect could be found at the lower end of the common duct (Fig. 2b)

The T tube was then clamped off except at night, for another 30 days when a recheck showed no indication of stone in the duct This warranted removal of the T tube and now 10 months later the patient weighs more than he ever did feels perfectly well and is back at his regular duties

Evidently in this case common duct drainage and time were needed for the pancreatic inflammation to subside and then proper measures dislodged the stone

We have come to believe that stones are present in the larger biliary ducts of the liver more frequently than is recorded More detailed examination of the liver at autopsy would support this statement, for during the last year we have demonstrated such stones in two instances but only after thorough search One of these was a patient with a postoperative common duct stone who also had an unrecognized carcinoma of the kidney The other case was one in which a routine autopsy was performed after the patient had succumbed to cardiovascular disease

The following case is presented because it demonstrates more vividly the release of intrahepatic stones into the common duct These stones were detected in the common duct by cholangiography and then were successfully dislodged by the aforementioned regimen

CASE 2 For 5 years Mrs R C aged 28 years had been having attacks of nausea and vomiting which were associated with loss of appetite slight upper abdominal distress but no true pain Removal of her appendix did not alleviate the symptoms but rather the attacks became more frequent Three days before entering the hospital she was suddenly seized with a sharp pain in the right upper quadrant which radiated to the right scapular region The paroxysm subsided under morphine She presented no history of jaundice but for some years she had noticed a pressure sensation immediately following meals which would last for half an hour and was not relieved by soda

Examination revealed a well developed young woman in no apparent distress The only positive finding was slight tenderness over the gall bladder No rigidity and no definite masses were palpable Her temperature and pulse were normal The white blood count was 10 400 and the icteric index was 10

Operation The large distended gall bladder was adherent to the duodenum The common duct appeared two or three times normal size with no stones palpable in its lumen After the gall bladder was removed it was incised and found to contain about 200 pea size stones The common duct was opened through the stump of the cystic duct by palpation probing scooping suction and irrigation re-



Fig 5 a, Cholangiogram at the table reveals no filling effect of the narrow common duct b, After 2 months with persistent draining biliary fistula, a defect inconstant in

size and shape was revealed on the cholangiogram c, After described treatment, the defect disappeared and in 7 days the fistula was closed

recovered no stones from the stools in such instances, but the patient's search for these is not always exacting Again, dislodgement of mucous plugs or inspissated bile may account for the therapeutic result. One should always keep in mind the potential danger of such treatment, and

until further investigative studies have been made, the dehydrocholic acid products should be prescribed cautiously in any degree of jaundice with supposition of stones in the common duct. If the jaundice is marked and the stools are acholic, great damage might be done to the liver



Fig 6 a, left, Stone is lodged above the upper end of the T-tube b, After removing T-tube and increasing biliary pressure, stone arrived at lower end of common duct. It could not be dissolved by Pribram's ether method nor could it be forced into the duodenum



Fig 3 a. left The cholangiogram reveals multiple stones in the common duct b. After the first course of treatment all but one stone had been removed and so recovered from the stool. Note rounded filling defect at lower end of common duct.

should be clamped off during the course of treatment except for 1 hour after each instillation of oil. Three to five decholin or procholol tablets ($3\frac{3}{4}$ grain) are given 4 times a day to increase and maintain the pressure within the common duct so that during some momentary period of relaxation the stone or foreign body may escape from the duct.

This treatment may be repeated after a day's rest and as in the second case reported, it may be administered as many as ten times over a period

of 2 months. It may prove rather exhausting at times, and a little caution must be exercised.

The question arises as to the indications for this form of treatment where no fistula or catheter set up for irrigation exists. If obstruction is complete there may be danger of hastening liver destruction by increasing biliary pressure. We have ventured to use this method in several cases in which obstruction was not complete with no evident harmful effects and with definite clearing up of the apparent biliary condition. We have



Fig 4 (same case as Fig 3) a. left After the second course of treatment the single remaining stone was dislodged and the contrast medium freely entered the duodenum b. The group of stones were recovered first. Later the single stone was recovered.



Fig 5 a, Cholangiogram at the table reveals no filling defect of the narrow common duct b, After 2 months with a persistent draining biliary fistula, a defect inconstant in

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Fig 6 a, left, Stone is lodged above the upper end of the T-tube b, After removing T-tube and increasing biliary pressure, stone arrived at lower end of common duct. It could not be dissolved by Pribram's ether method nor could it be forced into the duodenum

and dehydrocholic acid should definitely not be prescribed

This method of postoperative biliary tract flush is being instituted in more and more of our routine gall bladder cases in the hope of washing out remaining mucous plugs, blood clots that may originate from trauma, or inspissated bile which might be the nucleus of a stone, as well as to remove any remaining smaller stones, and thus avoid the later appearance of the so-called postcholecystectomy syndrome

Decholin (Riedel de Haen) and procholon (Squibb) were the dehydrocholic acid products used

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RETRACTION RING DYSTOCIA

Its Cause and Correction

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FOR many years uterine rings have been recognized as a cause of dystocia, yet the subject is one upon which the obstetrical world still seems to be rather confused. In a review of the literature, one finds that Braune, in 1872, wrote of a ruptured uterus from ring dystocia. Bandl, in 1875, defined a ring at the juncture of the upper active uterine body and the lower inactive cervix. Schroeder described a ring in normal labor at the union of the upper and lower uterine segments, which he designated a "contraction ring." Barbour and Lusk, also, were familiar with this ring, but, on account of the increased thickening of the body of the uterus, called it "retraction ring." More recently, Holmes, White, Harper, Fitzgibbon, and others, have written upon the subject.

During the past year, Rudolph, of Chicago, read a paper before the Obstetrical Section of the American Medical Association, on constriction ring dystocia. His report covered a series of 371 cases of ring dystocia, in which the maternal mortality was 15 per cent and the fetal mortality 46 per cent. No doubt these figures are not exceptional, yet, obviously, something is wrong with a situation in which the mortality could be so high. A clearer conception of ring obstructions from the anatomical, physiological, pathological, and therapeutic standpoints might go far toward reducing the number of fatalities for which they are responsible.

In the hope of throwing further light upon this subject, I shall give herein a report of my own experience with ring dystocias within the past several years. At the meeting of the Southern Medical Association in Dallas, Texas, November, 1925, I discussed before the obstetrical section my findings from research and practice through the years 1919 to 1925, inclusive. The cases upon which the present report is based have been observed since that time. They were, moreover, taken from my private practice. I make a point of this statement because I feel that private cases afford the most exact information. In the department for teaching of the University of Tennessee we have delivered over twenty thou-

sand infants throughout the same period of years. This work, on the whole, has been done by a number of persons, and, although the cases have been studied and evaluated, it is apparent that, in the circumstances, records of such rarely recognized conditions as uterine rings could hardly be accepted as accurate. My private patients, on the other hand, have received my personal attention.

According to my observations, retraction and contraction rings are by no means identical. The uterine retraction ring is a definite entity. It has certain distinguishing features:

1. The retraction ring is always at the juncture of the upper and lower uterine segments, in the annular layer of the submucous coat.
2. It is always palpable behind the symphysis at this juncture.
3. The body of the uterus is tense and painful on pressure so long as the ring persists.
4. The ring is found more often in long labors caused by malposition of the fetus.
5. The carbon dioxide combining power of the blood usually is low.
6. The ring is relaxed only by analgesia and anesthesia, and relief of acidosis when this condition exists.

7. Disproportion is often present.

Contraction ring, on the other hand, is characterized by the following:

1. It can take place at any point of the uterine musculature, since the active fibers run in both the circular and longitudinal directions.
2. The ring can occur after delivery if the placenta is retained.
3. The uterine body is not tense above nor below the ring, hence there is no pain on pressure.
4. Contraction ring is not especially related to malposition of the fetus.
5. All contraction rings are physiologic, they become obstructive only when some of the factors which produce the retraction ring are present.
6. Contraction rings are easily relaxed by mild analgesia and anesthesia.
7. There is no disproportion.

The validity of these observations can easily be appreciated by a study of the muscular structure of the uterus in pregnancy. The uterus is composed of three muscular layers of tissue: the

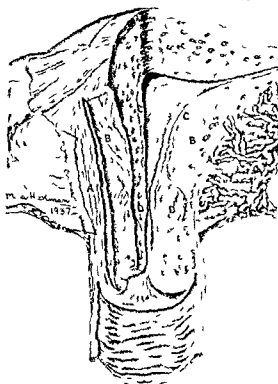


Fig 1 Schematic drawing showing the muscular layers of the pregnant uterus A Longitudinal muscle and the outer coat B central muscular layer composed chiefly of spiral and longitudinal fibers C the submucous coat D the annular layer of the submucous coat where the retraction ring always occurs E B C and D the layers from a different view

submucosum the stratum vasculare and the subserosum. There is no sharp demarcation between the layers of the uterine wall as is found in the walls of the intestine in the uterus the several layers of the myometrium interlace.

In the thin layer of muscle just under the serosa the fibers run principally in a longitudinal direction. At the juncture of the fornices with the vagina these fibers continue on to form part of the muscular wall of that organ. Between these longitudinal fibers are the transverse fibers which are active in contraction ring formation.

The fibers of the middle layer which run radially, constitute two thirds of the entire thickness of the wall. Because of its thickness and the numerous blood vessels which it contains the middle layer is known as the stratum vasculare. Its outer fibers adjacent to the stratum subserosum, are sometimes described as a distinct

layer, the stratum supravasculare. Aside from the fact that the muscles of this outer layer of the vascular area entwine about the blood vessels in a sort of figure eight arrangement no good reason exists for the special designation.

The innermost layer or stratum submucosum, as its name suggests, under the endometrium. This layer contains a large number of circular and oblique fibers which, at the fundus form the muscular rings around that portion of the tube and continue into the tube to form its circular layer. Below just above the internal os, is a thicker segment of annular fibers and it is at this point that the retraction ring is encountered.

An illustrative drawing of the musculature of the uterus is shown in Figure 1.

During pregnancy, the normal structures undergo profound anatomical changes. The individual muscle fibers are greatly augmented in number—not by a process of division of elements already present but by conversion of non muscular into muscular elements. At the same time the fibers increase at least ten times in size swelling from 40 to 500 micra in length. The nature of the physiological changes if any occur, can only be conjectured at the present time. It is unlikely that such enormous changes in anatomy would not be accompanied by equally important changes in physiology.

In the anatomical distribution of the muscular fibers of the uterus lies the mechanical basis for the waves of contraction that sweep over the organ during parturition. These waves begin at the fundus and involve for the most part the three layers, continuing to do so until the uterine contents engage the cervix the circular fiber then contract more vigorously in the wake of the fetus. Normally the circular contractions produce rings of constriction which are alternately loosened by the retraction of the longitudinal fibers. By this combined effort the fetus is pushed toward the outlet while accidentally the uterine rings are pulled back and slipped over the fetus in much the same manner as the snake pulls him self around his prey.

It is conceivable that failure of the longitudinal fibers to loosen these rings of constriction can throw the entire uterus into a state of contraction thus preventing its contents from moving outward. As has been stated constrictions of this type may occur at any point (Fig 2). They are initiated by some of the same factors which produce retraction rings but may be easily relaxed by mild analgesia and anesthesia. However, when the longitudinal fibers fail to loosen the segment of circular fibers composing the

TABLE I

Year	Number cases	Number rings	Para		Position			Rotat		Delivery		Forceps	
					Post		Ant			Nor	Ver		
			Prim	Mult	Lt	Rt		Man	For			Mid	Low
1925	70	3	3										
1926	278	7	5	2	2	1	3				3	1	1
1927	197	6	4	2	3	2	1					3	2
1928	273	5	4	1	2	1	2	1			4		1
1929	319	6	2	4	2		2			1	1	2	
1930	329	8	6	2	3	5		2	1		2	3	3
Total	1466	35	24	11	12	9	8	3	1	1	10	9	7

Analgesia morphine, scopolamine, and Gwathmey solution
Mortality fetal, 4 (1 14%), maternal, 0

TABLE II

Year	Number cases	Number rings	Para		Position			Rotat		Delivery		Forceps	
					Post		Ant			Nor	Ver		
			Prim	Mult	Lt	Rt		Man	For			Mid	Low
1931	277	18	14	4	8	7	3	2	10	1	2	11	4
1932	239	9	5	4	2	7				2	1	4	2
1933	258	8	6	2	3	3	2			1	2	3	2
1934	258	6	5	1	5	1	1	1	3	1		4	1
1935	243	4	2	2	3	1				1		2	1
1936	246	0											
Total	1521	45	32	13	21	10	6	3	13	6	5	24	10

Analgesia, 1931-1935 morphine, scopolamine, and sodium amytal
Analgesia, 1936 morphine, scopolamine, and nembutal
Mortality fetal, 3 (0 6%), maternal, 0

annular layer of the submucosum, which is known as the physiological retraction ring, the other layers are engaged in the constriction, the ring becomes thickened and rigid, causing obstruction, the cervix relaxes, the uterus above the ring becomes tense, and the abdomen is painful upon pressure. The physiological retraction ring then becomes pathological (Fig 3).

This pathological ring may obstruct with varying degrees of force. In the most severe form, every muscle fiber of the uterus is contracted and retracted, allowing no relaxation and producing in the uterus a condition of tetany. The tenseness may be so acute and so forceful as to compress the blood vessels supplying the fetus and lead to its asphyxiation. Occasionally, one sees a rupture of the lower uterine segment from overstretching and thinning of the walls (Fig 4). Microscopic sections have shown all the uterine muscle fibers retracted, that is, shortened and thickened, and the number, particularly the

spiral and transverse fibers, markedly increased. Rudolph described this development as a permanent, non-reversible constriction ring, which does not relax under anesthesia or drugs, or even after death. We have had 2 cases of this type, and an additional 2 have been observed by my associates White, Phillips, Carson, Hannah and Massey, and others, have reported similar cases.

ETIOLOGY

Bearing in mind the anatomical structure of the uterus, it would seem that there are four major causes of retraction ring dystocia. A number of minor factors may contribute, but in the final analysis these are basic: (1) malposition of the fetus, (2) early rupture of the membranes, (3) disproportion, (4) the response of the musculature to an abnormal blood chemistry.

If labor is severe from any cause, the normal chemistry of the blood may be altered, the carbon dioxide combining power is reduced, and

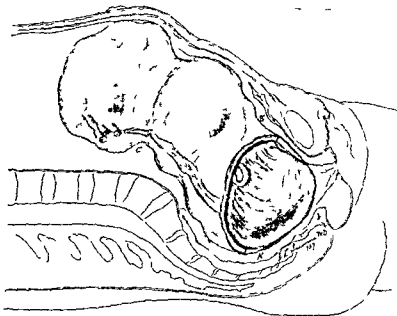


Fig 2 A Full dilatation B retraction ring C contraction

acidosis supervenes. Several years ago we observed that a number of our ward patients after being in labor for more than 18 hours suffered shock, and a few succumbed suddenly from the anesthetic. To our surprise we discovered that the anesthetist had ordered nothing to be given by mouth during the second stage of labor in order to prevent nausea in anesthesia. As a consequence the carbon dioxide combining power of the blood was found to be excessively low. It was these patients who suffered from ring formation.

Alkalosis also, may influence the development of pathological retraction ring but in our experience this condition has been so rare as to be regarded as an almost negligible possibility.

DIAGNOSIS

In making a diagnosis of retraction ring dystocia the following signs are to be considered:

1 Prolonged labor, that is from 12 to 36 hours.

2 Malposition and slight advancement of the fetus, the head or presenting part within the dilated cervix.

3 The appearance of a sulcus across the lower abdomen above the symphysis pubis at a level corresponding to the peritoneal attachment where the coronary vein crosses body of uterus.

4 Tenseness of the uterine body above the sulcus, and pain on palpation of the abdomen.

5 On vaginal examination a freely movable presenting part and a cervix dilated sufficiently to permit passage of the examining hand beyond the portion where the ring is found.

6 Low carbon dioxide combining power of the blood.

TREATMENT

The most important part of any medical procedure is treatment. In these cases the treatment consists of both preventive and curative measures. We believe that the great majority of uterine ring retractions can be prevented. Upon reviewing our cases since 1925, we found that the number of rings and long labors followed very closely the manner in which the patient was treated. Since we have had no retraction ring dystocias during the past 12 months we feel justified in concluding that our present method is successful. This method is given herein.

When the patient in labor arrives at the hospital, following the usual preparation she is examined both abdominally and vaginally. She then receives a rectal injection of 3 to 6 grains of one of the barbiturates. If this brings about cessation of pain and sleep during the intervals nothing further is given. When she begins to awaken and complain morphine sulphate $\frac{1}{4}$

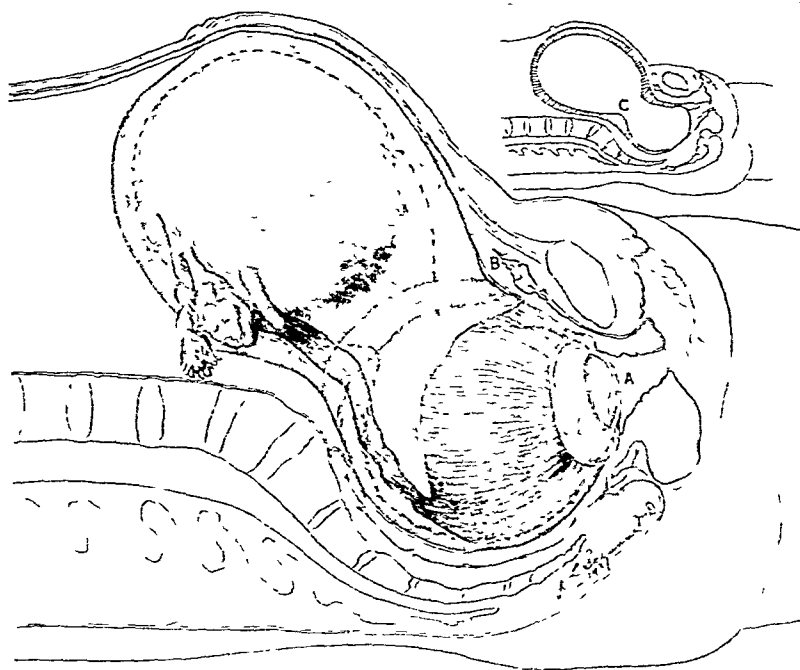


Fig 3 A, Dilatation, B, retraction ring, C, insert, where retraction occurs

grain, and scopolamine $1/200$ grain is given hypodermically. A smaller portion of this, alternating with 1.5 to 3 grains of one of the barbiturates, with scopolamine $1/300$ grain is administered thereafter as necessary. Fluids are given, if labor is prolonged, they are injected intravenously. Analgesia must be complete if good results are expected. It does not prolong, but, rather, shortens labor, and it does not affect the baby. By this method, the patient can be carried along for many hours in comparative comfort.

If the foregoing measures fail to prevent the development of a ring, or if a ring is already present when the patient is examined, a test is made for the carbon dioxide combining power of the blood. When this is found to be low, an intravenous injection of 1 to 2 per cent sodium bicarbonate is given. The analgesia is continued. If the ring persists when the patient is ready for delivery, 6 minims of adrenalin solution are given hypodermically for relaxation, and ether is administered. It is essential that both analgesia and anesthesia be allowed to take full effect before an attempt is made to deliver. If, in spite of analgesics, adrenalin, anesthetic, and sodium bicarbonate, the uterine retraction is not relaxed, tetany develops and the baby shows signs of distress, a cesarean section is indicated.

Since this treatment of sodium bicarbonate was instituted, about 2 years ago, we have not had the opportunity of giving it an extensive trial. In 2 of the 6 cases in which it was followed, delivery was made with low forceps, and in 2 delivery was spontaneous. In these 4, the ring disappeared entirely, and the uterus was slightly relaxed. In the 2 remaining cases the treatment had no effect.

Of vital importance is the correction of the acidosis or alkalosis before inducing profound anesthesia to relax the ring. We caused the



Fig 4 Ruptured uterus. Protrusion of extremity from the os and rupture below. Retraction ring at A.



Fig 5 Uterine retraction ring Sukus above the symphysis

death of several dogs before realizing that failure to correct the imbalanced chemical ratio before giving the anesthetic was responsible. In the past, I have known fatalities to occur, no doubt from this combination, which were attributed to cardiac thrombosis or embolus.

Our reasons for using sodium bicarbonate in preference to glucose or Hartmann's solution might well be explained. In carrying out some experiments upon dogs with acidosis, we found sodium bicarbonate much more effective, in fact, we produced an extreme acidosis in dogs by giving 2 per cent lactic acid solution. The normal ratio was restored by the use of a 2 per cent solution of sodium bicarbonate.

In this connection, I should like to state that sodium bicarbonate should never be given intravenously to a diabetic. Further glucose and sodium bicarbonate should not be given together, we killed 5 dogs with this combination.

Neglect of early treatment by proper analgesia and the prevention of acidosis or alkalosis may lead to the development of a severe type of retraction ring. The following case which was one of a series recently reported by an essayist, is a typical example of the effect of inactive treatment.

TABLE III

Average labor	22 1/2 hours	
Infant mortality	per cent	0.87
Operative incidence	per cent	91.2
Positions not listed in previous tables		
Breech		2
Face		1
Brow		1
Shoulder		1
Cause of stillbirths		
Cord around neck and body		1
Pig contracted on baby's neck (breech delivery)		1
Face presentation		1
Birth injury		1
Prolapsed cord		1
Another doctor attempted delivery		1
Ring on baby's head died later cerebral symptoms		1



Fig 6 Cesarean section for unrelaxed retraction ring Uterine tetany

The patient was a primipara aged 20 years. Labor began September 4 at 12:00 o'clock noon. The cervix was partially effaced. The right occiput was in the anterior position. On September 5 the cervix was dilated to 6 or 7 centimeters. By September 6 the cervical dilatation had not increased and routine treatment for exhaustion was given. The acetone test was negative. At 7:00 o'clock on the morning of September 7 the patient was shown the strain of labor; the cervix was dilated to 8 centimeters. Intra uterine examination revealed a ring around the neck of the fetus. Morphine and scopolamine were given as well as an intravenous injection of glucose. At 7:57 o'clock in the evening epinephrine was administered and at 6:30 a spontaneous delivery occurred.

It is my opinion that, if efficient analgesia had been given early in this case labor would have terminated at the end of 2 days rather than have been prolonged through the 4 days.

METHOD OF DELIVERY

Several years ago we regarded podalic version under deep anesthesia as the best method of delivery in retraction ring dystocia. In analyzing our cases from 1925 to 1930 we found 10 versions, 9 midforceps and 7 low forceps (Table I). From 1931 to 1936 there were only 5 versions, 24 midforceps and 10 low forceps (Table II). The fetal death rate was 14 per cent in the first group and 0.6 per cent in the second. There

TABLE IV

Delivery		
Forceps		1
Trophylactic		1
High		1
Mid		8
Version		4
Breech		1
Embryotomy		1
Total Cases		17
	Cases	Per cent
Infant mortality	3	17.6
Cerebral injury	3	17.6
Maternal mortality	0	0
Operative incidence	16	94.1

JAMES R. REINBERGER, M.D.

was no maternal mortality in either. In the light of our present knowledge, an attempt to turn a fetus in a tense uterus is a procedure which is open to criticism.

A statistical résumé of this study of 2,987 private patients is given in Table III.

One of my associates, Dr James R Reinberger, has tabulated a report of 17 cases from his private practice, which is presented in Table IV. Although the infant mortality of 17.6 per cent in his cases seems high, when one considers the number of cases and the fact that the series covers a period of years during which there was no well known routine treatment, the result is good. His operative incidence was 94.1 per cent. Ours was 91.2 per cent. In his series, also, there were no maternal deaths.

In closing, I should like to present two photographs loaned by Dr Raymond Wallace, of our staff. These show an interesting case of tetany uteri, caused by a retraction ring which failed to relax under analgesia and sodium bicarbonate. A section was performed, and both mother and baby survived. The rather high position of the sulcus, as shown in Figure 5, is due to the manner of photographing. In Figure 6, the tetanoid condition of the uterus is clearly apparent.

SUMMARY

- 1 Retraction rings are found, as a rule, in long labors.
- 2 Contraction rings are physiological, but become pathological under some of the conditions which produce retraction rings.
- 3 Retraction rings always occur at the junction of the upper and lower uterine segments, the annular layer of the submucous coat.
- 4 Tetany uteri develops when the force of the retraction is exaggerated.
- 5 Retraction ring may be prevented by effecting early analgesia and, when indicated, instituting measures to combat acidosis or alkalosis.
- 6 We have found a combination of the barbiturates, morphine, and scopolamine affords the most satisfactory analgesia.
- 7 Labor is shortened by proper analgesia, and the mother and baby suffer no harm.

8 The carbon dioxide content of the blood usually is low when retraction ring is present.

9 Sodium bicarbonate will restore a low carbon dioxide content to normal.

10 Lactic acid will correct an excessive alkalinity of the blood.

11. We have never found cesarean section necessary in ring retraction except in the presence of uterine tetany.

12. Fetal mortality from ring dystocias should be approximately 10 per cent. There should be no maternal mortality.

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Fig 5 Uterine retraction ring Sulcus above the symphysis.

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Operative incidence	per cent 91.2
Positions not listed in previous tables	
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Face	1
Brow	1
Shoulder	1
Cause of stillbirths	
Cord around neck and body	2
Ring contracted on baby's neck (breech delivery)	1
Face presentation	1
Birth injury	1
Prolapsed cord	1
Another doctor attempted delivery	1
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Fig 6 Cesarean section for unretracted retraction ring, Uterine tetany

The patient was a primipara aged 20 years. Labor began September 4 at 12:00 o'clock noon. The cervix was partially effaced. The right occiput was in the anterior position. On September 5 the cervix was dilated to 6 or 7 centimeters. By September 6 the cervical dilatation had not increased and routine treatment for exhaustion was given. The acetone test was negative. At 7:00 o'clock on the morning of September 7 the patient was showing the strain of labor; the cervix was dilated to 8 centimeters. Intra uterine examination revealed a ring around the neck of the fetus. Morphine and scopolamine were given as well as an intravenous injection of glucose. At 7:30 o'clock in the evening epinephrine was administered and at 8:30 a spontaneous delivery occurred.

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TABLE IV

Delivery	
Forceps	1
Prophylactic	1
High	2
Mid	8
Version	4
Breech	1
Embryotomy	1
Total Cases	17
Infant mortality	Case 3, 17.6
Cerebral injury	3, 17.6
Maternal mortality	0
Operative incidence	16, 94.1

JAMES P. REINBERGER, M.D.

The local application for 10 minutes of a pledget of cotton containing 25 per cent cocaine or other topical anesthetic agent usually will provide sufficient anesthesia to permit a gentle digital examination but not enough for a complete, painless instrumental investigation. The injection of a local anesthetic (preferably in oil) underneath the fissure usually is not necessary, although there is no objection to this procedure if it seems desirable to rule out malignancy before proceeding with surgical treatment.

The acute fissure of the anus is superficial, presents no appreciable induration, and is not accompanied by the so called "sentinel pile." There is usually marked spasm of the external sphincter ani.

The chronic fissure presents a more marked lesion associated with greater fibrosis (Figs. 7 and 8). Through the examining finger the surgeon senses more or less induration in the base of the lesion. Spasm of the sphincter varies from slight to marked.

The permanent cure of chronic fissures of the anus almost invariably requires operation, although some acute fissures can be treated successfully without operation mainly by measures to soften the stool. However, since we are dealing with the operative treatment of fissures, we shall reserve discussion of the treatment of acute fissures, and confine our remarks to the operative handling of chronic pathology.

A fibrous tissue mass or so called "sentinel pile" (Figs. 3, 7, and 8) usually overhangs the outermost extent of the chronic fissure or ulcer. It is not a true pile but results from chronic irritation following prolonged infection in the fissure or crypt.

ANAL PAPILLA

In addition to the "sentinel pile" there is frequently associated with the fissure an enlarged anal papilla or fibroma of the anal canal at the upper limit of the fissure (Figs. 3, 7, and 8). This is an enlargement of a normal structure, as the result of chronic infection at its base and repeated trauma from the passage of hard stool over the resistant pectinate line. This structure acts like a foreign body. At stool it is forced downward and insinuates itself into the fissure. It thus causes increased pain and mechanically prevents healing. Not infrequently it becomes long enough to protrude at the anal orifice.

CHRONIC CRYPTITIS, ABSCESSSES AND FISTULAS OF THE ANUS

It is easy to confuse the typical fissure just outside the pectinate line with a small ulcer which

forms locally as a result of infection in a crypt of Morgagni or the adjacent vestigial anal gland. (7) The pathology is different fundamentally. The fissure is located distal to the mucosal margin and primarily involves transitional epithelium. On the other hand, an ulcer resulting from an infected crypt is found to involve the mucosa just above the pectinate line, as well as the crypt itself beneath the shelving edge of transitional epithelium at the mucocutaneous margin. A "sentinel pile" often overhangs the chronically infected crypt.

In many cases, the fissure or infected crypt is associated with considerable active infection. The location of the fissure or crypt deep in the anal canal beneath the "sentinel pile" and between the folds of peri-anal skin tends to prevent free egress of infected discharge. The infection may spread upward to form a perirectal abscess in the submucosal space. Much more often, however, the infection spreads downward beneath the skin to form a subcutaneous, peri-anal abscess, which ruptures through the skin to form an associated fistula. This fistula is usually superficial and its external opening is most often located near the base of the fissure or "sentinel pile". There may be multiple external openings at varying distances from the pectinate line, due to extension of the initial inflammatory reaction, through liquefaction of the peri-anal fatty tissue. Rarely does the infection spread from a fissure or infected crypt into the space below and lateral to the levator ani to form a true ischioirectal abscess.

In selecting a fistula for operation in an ambulatory patient, one must be extremely cautious. Very frequently, it is most difficult to determine before operation the extent of the fistulous ramifications. One should select for this type of operation only those simple, uncomplicated cases in which the fistula is superficial and through which a probe can be easily passed.

INTERNAL HEMORRHOIDS

A satisfactory diagnosis of internal hemorrhoids can be made only by viewing them through the anoscope. Palpation is of no definite value. Except in extenuating circumstances, one should operate upon and keep ambulatory, only those patients who have one enlarged, protruding internal hemorrhoid. The others with more extensive pathology should be operated upon in the hospital.

OPERATIVE TREATMENT

The majority of patients suffering from anal disease present themselves for treatment after the lesion has become chronic. The chronic well

AMBULATORY OPERATIVE TREATMENT OF ANORECTAL PATHOLOGICAL CONDITIONS

194 Consecutive Operations Performed Under Local Anesthesia of Prolonged Duration

C V BURT, A B M D, F A C S, New York New York
J GORDON RENNIE, A B, M D, Richmond, Virginia

THE pathological entities of chronic fissures and cryptitis, hypertrophied papillae, simple uncomplicated fistulas of the anus, and single internal hemorrhoids are amenable to ambulatory, operative treatment in selected cases

There is some nervous and physical strain associated with this form of treatment. Patients who are highly nervous, and those who are in poor physical condition should not be subjected to this additional emotional trauma. The more affluent patients will prefer to be admitted to the hospital for any operative procedure.

By operating upon and keeping these patients ambulatory we have been able to save them their hospital expenses and in many cases have reduced their economic loss by returning them to work earlier than would have been possible had they been admitted to the hospital for the same operations.

We have included in this series (up to April 19 1937), 194 operations performed under anesthesia in 181 or 182 patients. Of these 194 operations, there are 124 for fissure, 34 for fistula, 10 for internal hemorrhoids, 4 for chronic cryptitis, 12 for chronic papillitis, 6 for combined cryptitis and papillitis and 4 for unhealed postoperative wounds.

From a practical standpoint typical chronic fissures and the chronic cryptitis lesions require the same treatment, namely excision and we have included both entities in our series under the caption of 'fissures.'

FIGURE OF THE ANUS

A true fissure of the anus begins as a linear laceration in the epithelium just distal to the mucocutaneous line (Figs 3 and 7). The lesion most commonly results from the passage of hard fecal

matter over the resistant pectinate line. Less frequently it is due to overstretching of the anus at childbirth. The presence of large internal hemorrhoids and particularly of hypertrophied anal papillae also contribute materially to the production of fissures. These structures exert their influence mechanically through the variation of stress as the stool passes by these masses at the pectinate line.

Symptoms. A fissure is one of the most painful anal lesions with which we have to deal. The anal canal distal to the mucocutaneous line abounds in sensory nerve terminals; hence it is extremely sensitive to contact with stool or other foreign objects. The most characteristic symptom of a fissure is a sharp knife-like pain during the passage of a hard stool followed by a dull aching pain for a few hours. In the chronic form there is usually a history of recurrent attacks of sharp pain at stool when the patient is constipated. These attacks last for periods of days to weeks and recur at intervals of weeks to months. The pain is frequently relieved when the stool becomes soft. The fissure not operated upon frequently heals and is broken down subsequently by the passage of a hard stool. Because of the pain the patient is afraid to move his bowels and increased constipation is the rule. The passage of hard fecal matter further traumatizes the lesion, sphincter spasm increases and a vicious cycle is established.

Examination. The fissure can be seen by properly retracting the perianal folds (Fig. 1) at the anterior or posterior commissure where nearly all of these lesions occur.

In a nervous patient with an active fissure, to complete the examination causes great pain and actually serves no useful purpose. It is far better to complete the instrumental part of the examination after the pain from the fissure has been relieved by appropriate surgical means. Every patient, before he is discharged, should have a sigmoidoscopic examination to rule out malignancy.

From the Department of Surgery, Prebyterian Hospital, College of Physicians and Surgeons, Columbia University, New York, New York.

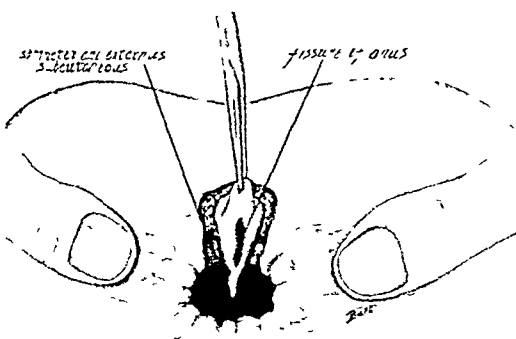


Fig 4 Skin incision extends above the mucocutaneous line to include the fissure, subfissure fibrosis, sentinel pile, and enlarged papilla

We have used benacol, anucaine, nupercaine, butecaine, and neothisol, as anesthetic agents. We have had the most satisfactory results with neothisol, the component parts of which are

Procaine base	1
Methyl methylene para amino phenylformate	2
Hydrobenzocarbinal	5
Refined French almond oil—q s ad	

Following the use of this formula we have seen none of the redness and severe itching which has been noted with some of the other formulas. The postoperative discomfort and pain, and particularly the wound necroses, have been lessened.

TECHNIQUE OF INJECTION OF ANESTHETIC IN OIL

A dry 20 cubic centimeter syringe is used. The anesthetic material is drawn into the syringe through a large caliber needle (gauge 15). This needle is replaced by one of much smaller bore (gauge 20), and of 2 to 2½ inches in length.

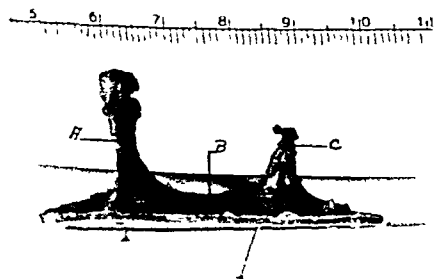


Fig 6 A, Hypertrophied anal papilla, B, fissure of the anus, C, sentinel pile

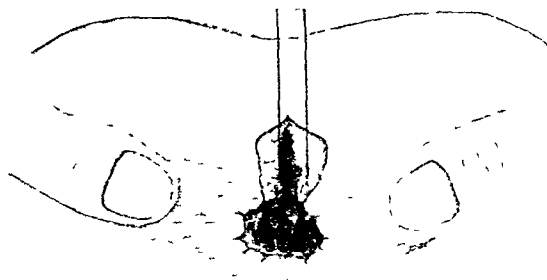


Fig 5 After removal of the fissure and its concomitants, the subcutaneous, external sphincter is incised. The incision extends into the deeper portion of the external sphincter. Sufficient skin is removed to permit free escape of the serosanguineous discharge. Short strips of plain gauze packing are laid into the entire wound.

The peri-anal skin is shaved. The anus and surrounding skin are cleansed with alcohol. The anal canal and rectal ampulla are not prepared other than with the enema. The skin through which the needle is to be introduced is prepared with tincture of iodine.

At the point of election for the introduction of the anesthetic, a novocain wheal is made with a hypodermic needle. The larger needle is introduced through this wheal. By passing this needle slowly in a circum-anal direction in the subcutaneous space, complete peri-anal anesthesia of

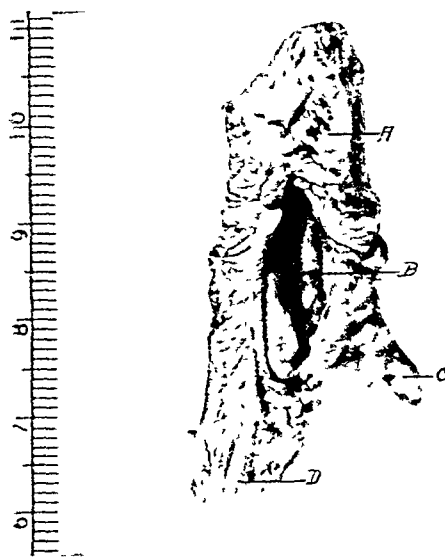


Fig 7 A, Sentinel pile or fibrous mass, B, typical fissure, C, hypertrophied papilla, D, mucocutaneous line

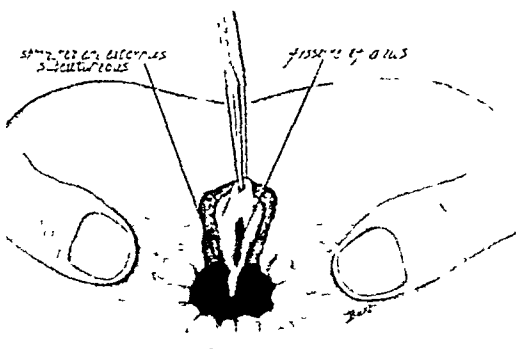


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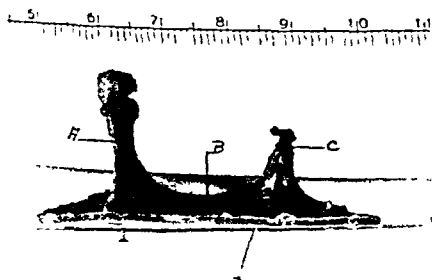


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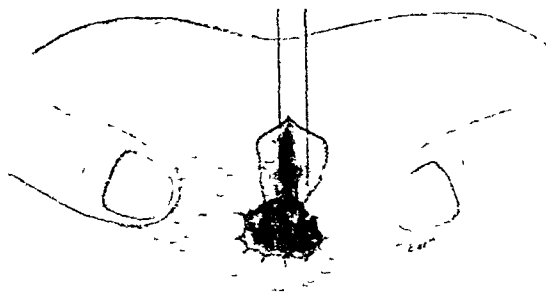


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The peri-anal skin is shaved. The anus and surrounding skin are cleansed with alcohol. The anal canal and rectal ampulla are not prepared other than with the enema. The skin through which the needle is to be introduced is prepared with tincture of iodine.

At the point of election for the introduction of the anesthetic, a novocain wheal is made with a hypodermic needle. The larger needle is introduced through this wheal. By passing this needle slowly in a circum-anal direction in the subcutaneous space, complete peri-anal anesthesia of

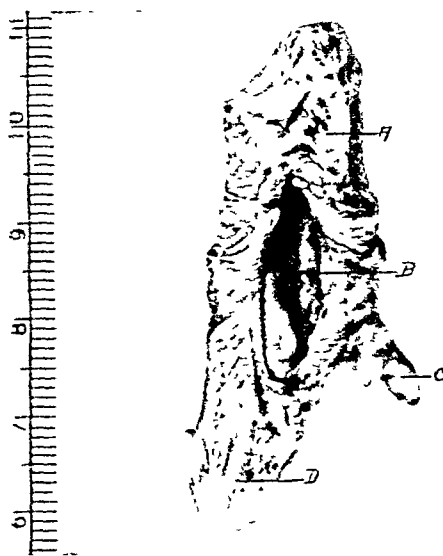


Fig 7 A, Sentinel pile or fibrous mass, B, typical fissure, C, hypertrophied papilla, D, mucocutaneous line

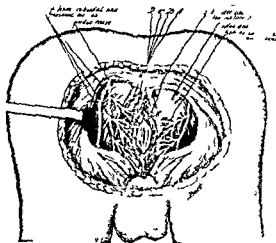


Fig. 1 Anatomical structures of the anal region. 18CD show the subcutaneous injection area on the left for posterior or lateral lesions. When this is repeated on the right, peri anal dermal anesthesia is produced for the posterior two thirds of the anal region. A similar injection in the right and left anterior quadrants produces complete cutaneous anesthesia for anterior pathology. A combination of these injections anesthetizes the complete cutaneous peri anal region.

established lesion requires operation. Palliative treatment is of little real value.

Pre operative preparation. The patient takes a soap suds enema and eats a light meal before he comes for operation. Our patients usually are not given any pre-operative sedation although there is no real objection to 3 grains of sodium amytal or other similar medication the night before and again 1 hour preceding the operation.

Position of the patient. Any position which is convenient and comfortable for the operator and patient is quite satisfactory. We prefer the knee chest position, although the Sims posture is very satisfactory.

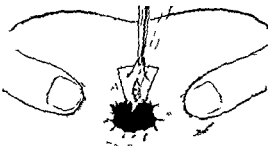


Fig. 3 Exposure of the fissure and enlarged anal papilla after relaxation of the sphincter. Triangular lines show the area of excision of the skin, sentinel pile, fissure and papilla.

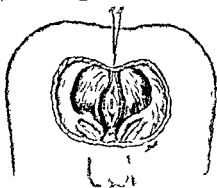


Fig. 2 Injection of the external sphincter. With the finger in the anal canal, the anesthetic material is laid down in the subcutaneous sphincter in the region of the dotted line. The needle is then passed in the same perianal direction but in a deeper plane to inject the deeper and more extensive portion of the external sphincter. A cone is placed in the ischio rectal fossa.

Selection of anesthetic. Our principal desire in the selection of an anesthetic for anal operations is to establish instantaneous and complete aresthesia with prolonged effect to relieve the pain for at least 10 to 14 days. After this time has elapsed granulation tissue has covered the sensory nerve terminals and there is no longer need for analgesia.

The effect of water soluble anesthetics—novocain for example—is of too short duration to provide the desired effect. The use of anesthetics in oil provides quite a satisfactory means of eliminating or greatly reducing pain and tenderness after operations for chronic anorectal pathology. Leomans, Gorsch and Mathesheimer in 1917 introduced the use of anesthetics in oil and thereby made an exceedingly important contribution to proctologic surgery. Since that time this method of administering anesthesia has been improved and used in various forms throughout the world.

The effect of this type of administration is instantaneous and complete. The duration of the anesthesia is difficult to determine because of the difference in the reactions of patients. Conservatively the duration of good analgesia may be said to be 2 to 3 weeks.

The oil should not be injected into the epidermis for an oil in the skin will cause a pressure necrosis. In the absence of frank infection, it may be introduced safely into the subcutaneous or deeper structures. There should be no pooling of the oil; this is assured by constant progress of the needle as the oil is injected.

mucosal region can thus be injected underneath the local lesion. Except when the lesion is extensive, it is not necessary to inject the entire submucosal region. It is entirely unnecessary and undesirable to inject into the ischioanal space. In many of our earlier cases we injected this space without untoward effect, yet the satisfactory results with perfect anesthesia in the absence of this injection, convinced us that it was unnecessary. The elimination of this step has removed the possibility of a deep abscess.

Amount of anesthetic agent In general, 15 to 20 cubic centimeters of the oil anesthetic agent is adequate for most anal operations. However, 25 cubic centimeters may be required for hemorrhoidectomy. Although the amount of anesthetic material will vary with the extent and location of the pathology, the following general distribution may be used in the case of a fissure of the anus:

- 3 c cm subcutaneously on each side
- 3 c cm in the subcutaneous and deep external sphincter on each side.
- 3 c cm underneath and around the local lesion

OPERATIVE PROCEDURE

Fissure or infected crypt An Allis clamp is placed in the lesion, and a hemostat is applied to the mucosa well above the pectinate line in the region of the local lesion to prevent retraction of the incised edge. The incision is made to include the sentinel pile, the fissure or crypt and the papilla above (Fig. 3). This incision is made generally in the shape of a triangle with its apex within the anal canal. The skin excision is made sufficiently wide externally to permit free egress of the serosanguineous discharge. If this excision is inadequate, the outer part of the wound will heal too fast, and the deeper portion will be very slow in healing or may even fail to heal.

Great care should be exercised to remove any enlarged papilla above or adjacent to the local lesion, as its presence will mechanically prevent healing and necessitate a second operation.

When the external skin incision is made, the skin edge is grasped and dissected free from the subcutaneous sphincter underneath, thus removing the fissure or crypt with the underlying fibrosis (Fig. 4). The dissection is carried to a point well above the pectinate line, where the pedicle is ligated for complete hemostasis. The subcutaneous, as well as part of the deep, portion of the external sphincter ani is incised, to produce satisfactory relaxation of the anal canal and to promote proper healing (Fig. 5).

It is particularly important not to incise completely through the deep portion of the external

sphincter ani. Permanent incontinence will not result if a portion of the true anal canal, including the innermost margin of the levator ani (puborectalis), is left intact. If the entire anal canal is incised, partial incontinence may result.

Plain packing is placed in the wound, preferably in short strips of $\frac{1}{2}$ inch width. A pad of gauze is then placed over the anus, and the buttocks are pulled tightly together with adhesive for hemostatic purposes.

Postoperative care At the end of 48 hours (second day), the external padding is removed. The packing is not disturbed because bleeding is likely to occur if it is removed at this time.

The patient is instructed to take 2 ounces of milk of magnesia on the morning of the second day, to be followed by a soap suds enema later in the same day if he has not had a satisfactory movement. He is also instructed to take hot sitz baths for 20 minutes, twice a day. The water should be gradually made hot to avoid weakness and should be cooled off at the end of the bath to prevent the patient from taking a cold.

The packing is permitted to come away with the first or second stool. If it has not been expelled by the end of the third or fourth day, it is removed. The danger of hemorrhage incidental to pulling the packing away has passed.

During the first 48 hours after the operation, the patient is given a light diet of tea, toast, milk, cereal, and eggs. After 48 hours, a regular diet is prescribed. If a movement becomes necessary during the first or second day after operation the patient is told to take off only the outside dressing. The packing is usually not expelled and we have not seen any hemorrhage as a result of a movement prior to 48 hours. Sufficient codeine is administered to eliminate any pain.

After the packing has been removed and the bowels are functioning adequately, it is important to dress the wound frequently, say every second or third day, to be sure it closes from within and not from the adherence of the raw surfaces. This can be most easily done by passing the index finger into the anal canal and bringing it out through the depth of the wound, which continues anesthetized for some 2 to 3 weeks after the operation.

Fistula of the anus A probe is passed through the fistula, or the tract is injected with methylene blue. The anesthetic material is injected around the local lesion, and not throughout the peri-anal region, as would be required in a more extensive operation. The skin overlying the tract is excised widely so as to permit free drainage. Great care must be exercised to remove, if possible, the internal opening, which is usually to be found in an adja-

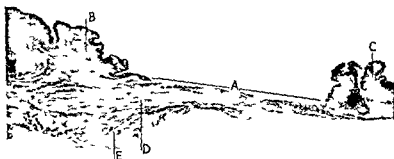


Fig. 8 Low power of a typical fissure *A* is seen between the sentinel pile *B* and a small anal papilla *C*. The longitudinal smooth muscle bands of the intestine are visible at *D* and the circular muscle fibers at *E*.

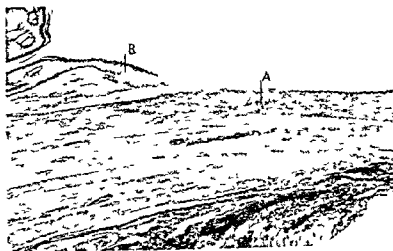


Fig. 9 High power of the fissure as shown in Figure 8 presenting the fibrous tissue and cellular infiltration *I* underneath the fissure with the squamous epithelium of the sentinel pile *B*.

the skin can be produced (Fig. 1). Great care must be exercised to prevent intradermal deposit of the oil, which will produce necrosis.

If the lesion is located only in the posterior region, the anesthetic agent can be introduced through one skin puncture about 1 to 1½ inches posterior to the anal ring. If it is located anteriorly it is desirable to introduce the anesthetic material through the skin in either or both the right and left anterior quadrants about 1 to 1½ inches from the anal verge. In this way more complete and satisfactory anesthesia can be produced than through one puncture wound.

If hemorrhoidectomy or excision of multiple crypts is to be done, the posterior and the two anterior injections should be combined.

After the anesthetic material has been introduced into the subcutaneous space around the anus, the index finger is introduced into the anal canal, the needle is passed on either side into the subcutaneous portion of the external sphincter and this structure is thus completely injected. Then the deeper and more extensive part of the external sphincter is infiltrated with the oil (Fig. 2). Should this deeper portion including the puborectalis be too extensively infiltrated a temporary incontinence may result. If this should occur it is of little consequence as the sphincter tone returns in about 10 days when the major portion of the anesthetic effect has disappeared.

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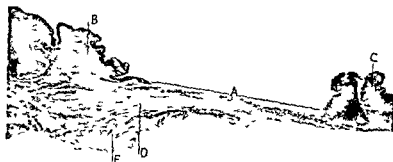


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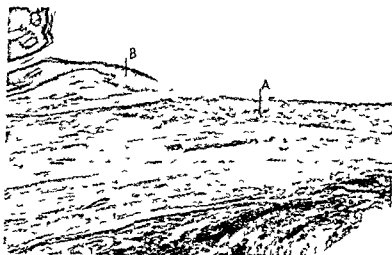


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Chronic crypto-papillitis. Six, or 3 per cent, of our operations were performed for a combination of chronically enlarged crypts and papillæ

Postoperative wounds. Four, or 2 per cent, of these operations were performed for persistent postoperative wounds, following excision for local anal pathology. We were unable to explain the persistence of these wounds except for the possible inadequate excision of skin surrounding the local lesion at the time of the previous operations. These wounds healed firmly after the additional skin was excised

POSTOPERATIVE HEMORRHAGE

In our earlier cases we inserted considerable packing and removed it at the end of 48 hours. This resulted in bleeding in a number of the cases. Since we adopted the principle of inserting a small amount of packing in short strips and permitting this to come away with the stool, we have had almost no bleeding. Up to the time the method was changed, we experienced slight bleeding in 13 patients, moderate in 13, and marked hemorrhage in 5 cases, although not of sufficient magnitude to impair the hemoglobin balance. Packing was reinserted in 10 instances, and ligation was done in 3 patients. In only 1 instance in our series of 194 operations, was it necessary, on account of hemorrhage, to keep the patient in the overnight ward for 1 night. One other patient with slight loss of blood felt weak following operation and was confined to the overnight ward

INFECTIONS AND REACTIONS

Following the use of the prolonged anesthesia in 194 operations, we have observed two generalized reactions. Whether these represented toxic manifestations or were emotional responses, we are unable to say.

Immediately after the injection was completed, the patients lost consciousness to regain it in a few minutes, after which they alternately responded and failed to respond every few minutes for about one-half hour. At the end of this time, consciousness was permanently regained. At the onset, the pulse became very weak and seemed to alternate with consciousness. The skin was dry at all times. There was no twitching or other localized sign. These patients were kept in the overnight ward and were discharged the next morning in a normal state. There was no subsequent reaction.

We have experienced a few untoward local reactions, but these have been so few as to be almost negligible, and certainly would not interdict the use of this type of anesthesia by an experi-

enced surgeon. The indiscriminate use of local anesthesia by means of oil injections by inexperienced operators is certain to result in unfortunate complications.

In a few of our early cases, we noted the appearance of much redness and severe itching, with slight induration of the entire peri-anal region, beginning 2 to 5 days after the operation and lasting for 7 to 10 days. This could have been due to iodoform in the packing, but its appearance in some cases in which plain packing was used, leads us to believe it was due to the anesthetic agents. Since we have been using neothisol, we have noted none of these reactions.

In one of our earlier cases (464,518) necrosis of the skin followed the introduction of the oil into the skin around part of the wound. In one operation for fissure (282,339) a posterior, midline fistula was discovered deep to the wound after healing had progressed almost to completion. This fistula was complete, its walls were thick, and we believe that it had been overlooked as a blind, internal fistula at the time of the pre-operative examination. Excision of this fistula with patient under prolonged anesthesia resulted in complete, satisfactory healing. In another patient (M.D.) a blind external, incomplete fistula, without well formed walls was discovered deep to the fissure wound several days after the operation. We believe that this resulted from pooling of the oil. A simple incision through the intervening tissue, without anesthesia, resulted in an open wound, which healed satisfactorily in about 10 days. One other patient presented a blind external fistula, which extended upward and lateral to the anal canal wall. This was believed to be due to infection in the presence of pooling of the oil. Excision of this fistula resulted in complete healing.

In six instances there was superficial necrosis in the area of maximum deposit of the oil underneath the local lesion. The patients were not aware of these local reactions, and they were of no clinical significance.

In two of our more recent cases of fissures, in which we were operating with new anesthetics, we observed extensive, subcutaneous abscesses around the anus. These necessitated confinement of the patients to bed intermittently for a few days. Neither was admitted to the hospital. One of these required incision and drainage of the abscess. The other ruptured spontaneously. Each of these healed up satisfactorily and the patients presented no incontinence or other complaint.

In considering all of our patients operated under anesthesia, administered in oil, 12, or 6 per cent, presented necrosis of the tissue. Of this number,

cent crypt of Morgagni. Although desirable, it is not necessary to excise the entire circumference of the tract, as the granulation tissue will be covered with epithelium if the tract is laid open and adequate drainage is established. The insertion of packing and the postoperative treatment is exactly the same as for the fissure of the anus.

Papilla, hypertrophied. The anesthetic agent is injected only underneath the immediate lesion and local excision is performed. It is usually not necessary to incise the subcutaneous sphincter except if spasm is marked. The insertion of packing and postoperative care are the same as for fissure.

Internal hemorrhoid. The anesthetic agent is introduced as described under 'fissure'. The internal hemorrhoid, together with its external counterpart, is dissected down to a pedicle of mucosa, which is ligated. Hemostasis is established, plain packing is inserted in short strips. Postoperative care is that described under 'Fissure'.

ANALYSIS OF CASES

A total of 211 consecutive operations were performed on 181 patients. Most of these were done in the Vanderbilt Clinic by, or under the direct supervision of the senior author. A few operations were performed on private patients. In 194 operations the anesthetic was injected in oil. In the 17 remaining cases 2 were given spinal anesthesia, 6, novocain 3 had no anesthetic given and 6 were given a general anesthetic. Twenty two of the 181 patients required a total of 50 operations, and in 34 of these the anesthetic was given in oil.

Sex. The female seems to be more susceptible to this general type of pathology. 117, or 64.6 per cent of the 181 patients were females. 64 or 35.4 per cent were males.

Age. The average age of the 181 patients on whom these operations were performed was 39.8 years. The average age of the males, 42.2 years was slightly above that of the females who averaged 37.6 years. The youngest patient was 18 and the oldest 62 years.

General reactions of patients. While most of our patients have experienced no pain others have complained of more or less pain for a few hours after the operation. We believe that incomplete initial anesthetic effect prevails when these patients complain of severe postoperative pain. Their pain is not very severe, as it is relieved by one to three doses of codeine, $\frac{1}{2}$ grain and aspirin 5 grains. When the initial discomfort subsides usually within 5 hours the patient is almost invariably comfortable throughout the postoperative course.

Some of our patients, a minority, have complained of slight weakness for a few days but all of them have remained ambulatory and have reported to the office or clinic for dressing on the second postoperative day. In the majority of instances these patients have been able to perform their essential household duties within 2 or 3 days and have resumed regular work within a week.

Fissures. Of the 194 operations which we considered it safe to perform in ambulatory patients, 124 or 63.9 per cent, were performed for fissures of the anus. Of this number 107, or 86.3 per cent were in the posterior commissure. The remainder of 3, or 2.4 per cent, were located in both the anterior and posterior commissures.

Fistulas. A total of 34 or 17 per cent, of the 194 operations done under prolonged anesthesia were performed for fistulas of the anus. Twenty nine of the patients were operated upon for primary fistulas, and the 5 remaining occurred or were discovered subsequent to one or more operations for pre-existing anal pathology. Twenty eight or 82.3 per cent, of these 34 were located in the posterior anal region. Five, or 14.7 per cent were located in the anterior region of the anus. The remaining case, or 3 per cent, was in the lateral (left) wall of the anus. Two, or 5.8 per cent, of the fistulas presented upward extensions into the submucosal space, in addition to the usual subcutaneous advance and external rupture. Of the 5 fistulas which are included in the re-operated upon group their presence is explained as follows. One was thought to have been overlooked prior to the first operation as it presented thick walls, 1 definitely was due to retained linen ligature knots at the time of a previous operation. 1 was an old ramification from an extensive posterior fistula of the anus which had been previously operated upon twice for other extensions, the fifth one was not satisfactorily explained.

Internal hemorrhoids. Ten or 5.1 per cent, of the 194 operations were for one or two large internal hemorrhoids. In this group we prefer to include those patients with only one large hemorrhoid.

Chronic cryptitis. Although we might easily say that almost all of the patients with fistulas were operated upon for chronic cryptitis and fistulas we have operated upon only 4 or 2.0 per cent of our cases for chronic cryptitis alone. These patients complained principally of anal pain and presented enlarged crypts associated with local tenderness.

Papillitis. Twelve or 6.1 per cent were operated upon for enlarged anal papillae all of which were protruding at the anus or causing discomfort at stool.

patients, 6 presented persistent pruritus ani, which was the principal pre-operative complaint. Seven of these 115 patients continued to have occasional bleeding from internal hemorrhoids. One of these was sent into the hospital subsequently for hemorrhoidectomy. The 6 other patients received injections for the hemorrhoids. One patient complained of chafing, and another of some anal pain, the causes for which were not apparent.

CONCLUSIONS

1 It is safe to operate upon selected ambulatory patients under prolonged anesthesia administered in oil for chronic anorectal disease.

2 Great caution must be exercised in the use of this type of anesthetic, because of the potential danger of infection and peri-anal necrosis. Much experience is required for its proper management.

3 Anesthetics injected in oil are slowly absorbed and produce prolonged, effective anesthesia for 2 to 3 weeks or more.

4 This prolonged anesthesia not only greatly reduces the postoperative pain and tenderness but permits the patient to be ambulatory and often to return to work earlier than would be possible under other types of anesthesia.

5 In 194 operations the anesthetic was administered in oil on 181 patients.

6 An average number of 8.58 dressings were required per case in the entire series.

7. A healing time of 44 days per patient was recorded in the healed cases.

8. One hundred and sixty-one, or 88.9 per cent, of these patients were known to be healed, while the remaining 20, or 11.1 per cent, were lost to follow-up before they were recorded as healed. These results are based on personal observation in

155, or 96.2 per cent, of the healed patients. The 6 others replied by letter.

9 One hundred and fifteen, or 71.4 per cent, of the 161 healed patients were followed for more than 6 months which is considered to be a fair follow-up period in these cases. One hundred, or 86.95 per cent, of these 115 patients were symptom free after 6 months.

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only 6 or 3 per cent were of clinical significance. In reality, only 2, or 1 per cent, of the cases could be said to present infection of clinical significance directly and definitely attributable to the anesthetic.

CAUSES FOR RE OPERATION

Twenty two patients required a total of 50 operations. Only one of these was not healed when last seen. Thirty four of these operations were performed under prolonged anesthesia: 5 under novocain, 6 under general, 2 under spinal, and 3 had no anesthetic. Of the 22 primary operations, 18 were for posterior fissures, 1 for chronic cryptitis, 2 for fistula and 1 for external thrombosed hemorrhoid and excess skin. Seventeen patients required 2 operations each, 4 required 3 operations and 1 necessitated 4 operations. One of the patients suffered from a very extensive fistula of the anus and had had 2 operations under spinal anesthesia in the hospital prior to the third one which was done under prolonged anesthesia and which cured the condition. The patient requiring 4 operations had the first one in the hospital for fistula of the anus, which failed to heal apparently because of the presence of enlarged papillae. General anesthesia was used.

Secondary operations were made necessary for the following reasons: in 1 case recurrent fissure; in 2 cases insufficient skin excisions; in 1 case, an infected crypt; in 1, a retained non absorbable ligature knot; in 2 unhealed wounds without apparent cause; and in 9, enlarged papillae which had been overlooked at the time of the primary operations.

In the 21 cases in which 2 and 3 procedures were required, the intervals between operations varied from 1 to 8 months. The average time elapsed was approximately 2 months. The patient who required 4 operations was given intervals of 6 months, 2½ years, and 3 weeks respectively.

These facts are of sufficient magnitude to emphasize the necessity of great care in removing any enlarged anal papilla and in preventing pooling of the oil. Any ligature material of the non absorbable variety should be cut long so that a small knot will not be retained to prevent proper healing. Sufficient skin should be removed to prevent premature healing of the skin over the deeper portion of the wound and to permit adequate, prolonged drainage.

NUMBER OF DRESSINGS REQUIRED FOR EACH PATIENT

Taking into consideration all of the 160 operations performed under prolonged anesthesia, an

average of 8.58 dressings was required for each patient. In this group we considered only the number of dressings after the final operations in the re operated upon group. Of these cases 88 fissures required an average of 8.3 dressings, 25 fistulas averaged 8.76 dressings, 20 patients in the re operated upon group showed an average of 9.14 dressings following each of the final operations; the 14 cases of cryptitis and papillitis averaged 7 dressings, the 8 hemorrhoid excisions, 7.6 dressings, in the miscellaneous cases, in which two severe perianal abscesses occurred, an average of 10.4 dressings were required for each patient.

HEALING TIME

In 157 patients in this group in which the healed dates are recorded an average of 44 days was required for healing. In 157, or 97.5 per cent of the 161 patients known to be healed the date on which healing was known to have been complete is accurately recorded. In 85 fissures the wounds were known to be healed on an average of the forty fourth postoperative day. Twenty five fistulas required an average of 46 days to heal. In 20 of the re operated upon patients, and in 14 who were operated upon for cryptitis and papillitis, the average healing time was 41 days. The patients operated upon for internal hemorrhoids required 38.6 days to heal, and the miscellaneous group containing two severe perianal infections required 56 days to heal.

FOLLOW UP

Of a total of 181 patients operated upon under prolonged anesthesia, 161 or 88.9 per cent were known to be healed when last seen. The remaining 20, or 11.1 per cent, were lost to follow up before they were healed. The follow up results presented herein are based upon personal observations in 155 or 96.2 per cent, of the 161 known healed patients. The 6 remaining healed patients, 3.8 per cent, replied by letter to persistent follow up inquiries. Of the 161 patients known to be healed 136 or 84.5 per cent, were followed for more than 3 months, 115 or 71.3 per cent, were followed for more than 6 months, 68 patients or 42.2 per cent, were under observation for more than 1 year, 14, or 8.7 per cent, were followed for more than 2 years.

SYMPTOM FREE

We shall consider 6 months as a satisfactory follow up period in these cases. Of the 115 patients followed for more than 6 months, 100 or 86.95 per cent, were symptom free at the end of 6 months following their operations. Of these 115

sedatives and heat supplied by the use of warm blankets and hot water bottles, or by placing the patient in a tent or room kept at 90 degrees F. A lowered blood pressure must be treated by the administration of stimulants and fluids given intravenously. Of equal importance in preventing shock is the gentle handling of the patient in quiet and peaceful surroundings. The cleansing of the wound should be done with the greatest of care and without trauma. The insensible loss of body fluids as determined by blood concentration tests must be relieved promptly by the administration of fluids. The best way to do this is by the intravenous administration of blood plasma. This, of course, must be typed as for a blood transfusion. In addition to this, sufficient intravenous infusion of normal or hypertonic salt solution must be given to maintain the blood chlorides at a normal level.

The aseptic treatment of burns was long completely disregarded especially during the period of the use of carron oil. Burn wounds must be treated as carefully as other surgical wounds to avoid infection, and good results cannot be expected simply from the tanning alone. The surrounding unburned skin must be kept scrupulously clean being frequently washed with an antiseptic solution, 70 per cent alcohol being a satisfactory one. Sterile bed linen must be used if infection is to be avoided. No attempt to dissolve the coagulum or to loosen it by the application of wet dressings should be made. This is well illustrated in Davidson's original paper: a convalescing patient so treated was thrown into a condition of marked toxemia within a few hours.

The question of whether or not there ever is actually a toxemia of burns remains unanswered. There is considerable evidence that it does occur even though the toxic substance itself has not yet been isolated. The important thing, however, is a rational treatment of the

patient which includes the prevention or treatment of shock, the prevention of infection and the production of an aseptic protective coagulum. The latter in its turn prevents fluid loss and is an aid in preventing infection and we believe may be of some value in the prevention of dissemination throughout the body of toxic substances.

This modern treatment of burns accurately followed has resulted in a noteworthy saving of life, in markedly lessening deformities, in decreasing hospitalization, and in abolishing expensive dressings. ROY D. McCLURE.

IN recent years there has been a more general recognition of the requirements for the proper care of burns. Linked with this changing attitude there is an increasing appreciation of the nature of the profound systemic changes which so often complicate these injuries.

Because they represent the commonest variety of burns, those produced by heat of a degree incompatible with proper functioning of the tissues have been most intensively studied. The symptoms following the infliction of a severe burn may be divided into three groups: the period of initial shock; the period of secondary or so called toxic burn shock; and the period of repair, which may or may not be complicated by infection. The cause of the constitutional symptoms immediately following burns has long been a matter for speculation and research, both clinical and laboratory. The term "shock" has been loosely applied in clinical medicine, and failure to define accurately conditions under discussion has given rise to confusion in the study of the clinical pathology of burns. Primary shock is neurogenic in character, and is associated with vasodilatation and a decrease in blood pressure, and a consequent reduction in cardiac

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THE MODERN TREATMENT OF BURNS

PERHAPS not in this century has one surgeon accomplished so much in the saving of life, the lessening of suffering, and the saving of patients' time and money, as has E. C. Davidson by his work first published in 1925. Since that time there has been an enormous amount of work done on the subject and many chemicals have been used in the treatment of burn wounds. It is questionable, however, whether any of these offer any improvement over the tannic acid treatment if this is carried out properly. Those of us who worked with Davidson for two years before the method was described in the literature and have since tried the different methods suggested, find merit in some of them but not enough, we believe, to affect the death rate materially. The most significant result, however, of Davidson's work is the tremendous renewal in the interest in the subject of burns. To avoid any controversy over the

chemical to be used the French have appropriately introduced the term "tanning method of treatment."

Davidson pointed out in his original contribution the equal importance of the prevention or treatment, of shock and the need of absolute asepsis. We still feel that the tannic acid treatment is most satisfactory if surgical principles are observed. Aseptic methods are always of much more importance than are antiseptic solutions. Two great principles should be observed in the treatment of burns. These principles are fundamental in all types of wounds. They are the treatment of shock and the practice of asepsis. Therefore, if the physician or surgeon would simply regard a burn as a surgical wound to be kept surgically clean, much of the problem would be solved.

Some of the difficulty perhaps lies in the fact that except in larger centers the individual practitioner rarely has the opportunity of observing and treating severe cases. Last year in the United States there were approximately 7,000 deaths resulting from burns. If these cases were equally distributed among the 130,000 practicing doctors each would see only one fatal case in each 18 years of practice. For this reason it is difficult for the physician to bear in mind the details of treatment and natural for him to place his faith in applications to the burned area rather than in the adjunct treatment so essential for a success.

The injury produced by burns, whether by flame, hot water, or electricity, is very prone to result in shock. No satisfactory response to any type of treatment therefore can be expected until the condition of shock is either prevented or relieved. Pain and restlessness should be alleviated by the administration of

colored membrane which acts as a protective coating against chemical, bacterial, and mechanical action, as well as against sensory irritation from other sources. One striking effect of the use of tannic acid is the relief of pain, which occurs promptly and often makes further use of sedatives unnecessary. Various modifications of this treatment have been proposed.

The tanning process is a complicated one, and the importance of using solutions of a normal hydrogen-ion concentration has been well demonstrated. The acid solutions usually used produce a very rapid fixation of tannin on the surface and have a tendency to augment the edema of the underlying tissues. McClure recently demonstrated that evaporation from the burned surface has a negligible effect in producing dehydration after a burn. For this reason the early arguments advanced for the use of tannic acid, on the basis that it prevents water loss from the surface, cannot be given much weight. Regardless of its ultimate place in the therapy of burns, Davidson's contribution served to stimulate a revival of interest in this subject. At the present time it is not possible to demonstrate by the statistical method the effect which the tannic acid method of treatment has had upon mortality. It is probable that a more general appreciation of the nature of the systemic changes has had as much to do with any apparent decrease in the death rate as has any single method of treating the local wound. The routine use of blood transfusion and the addition of fluids and chlorides to the depleted vascular supply have been important factors in reducing the mortality rate during the first few days. In some reported series more patients survived than formerly the periods of initial and secondary shock only to die at a later stage of exhaustion, sepsis, or pneumonia.

The fact that the mortality rate in the early stages may be lowered means that more pa-

tients will reach the stage of the large granulating wound. The treatment of these wounds offers a challenge which is worthy of any surgeon. These patients present the problems of maintenance of body nutrition, the control of infection, the preparation of the granulating surface for the reception of skin grafts, the grafting of skin, and the prevention of contractures and ankylosis. Mastery of the techniques involved in the accomplishment of these various objectives is far from being universal. The application of pressure dressings for the control of exuberant granulations is an old method which has assumed only within recent years a place consistent with its value.

Large granulating wounds should be covered with epithelium at the earliest possible moment. The derma, or true skin, is derived from the mesoderm and is, therefore, a tissue which is not designed to serve as a source of epithelial development. While small areas of the stratum germinativum of the epidermis may remain viable in extensive burns, and at times undestroyed hair follicles may act as centers for the growth of epithelium, one should not delay too long in the hope that epithelization will be brought about in this manner. Ingrowth from the margins of the wound is to be relied on only in burns of small area. Delay in epithelization means an increase in scar tissue and greater deformity.

The protracted suffering of the unfortunate victims of these tragedies, and the resulting disfigurement and loss of morale present important economic as well as surgical and medical considerations. In the past the management as well as the care of these patients has been relegated too often to the youngest house officer. It is encouraging to note that within recent years leaders of surgical thought have given these problems a degree of consideration more nearly consistent with their importance.

STANLEY J. SEEGER.

output While this syndrome should always be looked for, it is usually found only in wide spread burns affecting numerous nerve endings in the skin It is concerning the so called secondary toxic burn shock that much controversy exists The controversy concerns both the mechanism of its production and the time factor involved Two schools of thought predominate regarding the fundamental character of this reaction One maintains that at the site of the burn a toxic substance is elaborated by the action of heat on proteins It is presumed that the absorption of this toxin gives rise to the symptoms grouped under the term "toxic burn shock" Other workers maintain that it is unnecessary to postulate the existence of a specific burn toxin, and substitute the theory that the symptoms can be explained by the shifting of fluids in the body

In 1898 Bardeen reviewed the various theories on this subject His conclusions, based on observed changes in the entire lymphatic systems of five children who died several hours after being burned, were a substantiation of the theory that death at this stage is due to toxemia Blalock and others have done important work which does not confirm the presence of a toxin such as earlier experimental results seemed to prove Wilson has come to the conclusion that evidence for a specific burn toxin is inconclusive although much of it is suggestive He maintains that proof of the toxin theory requires the demonstration and identification of the toxic substances not only in the burned area, but also in the circulating blood Working with others he demonstrated in experimental animals the development of toxicity in the edema fluid which accumulates in a burned area, this property being gradually acquired over a period of 48 hours Controversy exists as to the possibility of absorption of toxic material from a burned area Underhill maintains that fol-

lowing a burn the permeability of the capillaries is in one direction only, namely from the capillaries to the tissues Recently Mason has demonstrated the absorption of potassium iodide from burned areas, the excretion of this substance being the same as in normal animals

The confusion regarding the use of the term "toxic burn shock" is exemplified by the existing opinions concerning the time of onset of this syndrome One author states that it occurs 1 hour after the infliction of a severe burn, another, that it may occur from 6 to 50 hours afterward, and a third states that all shock seen during the first 24 hours is primary in character Harkins' experimental demonstration that in a burned extremity half of the fluid lost from the blood vessels to the tissues is lost within the first hour is of importance in considering the time of onset of secondary shock Some evidence has been advanced which tends to show that infection plays a rôle in the production of this early toxemia Infection is probably not an important factor earlier than the second day in many cases The early theories which attributed the reaction to burns as due to interference with the functions of the skin have been generally discarded although it is becoming apparent that our knowledge of the physiology of the skin is far from complete

In 1925 Davidson suggested the possibility of limiting the absorption of toxic material from burned surfaces by coagulation or precipitation of injured proteins His studies of the efficiency of various agents led to the development of the tannic acid method of treating the local wound Because tannic acid possesses the property of precipitating protein Davidson assumed that through its use fixation of the burned tissues could be accomplished and the absorption of toxic material prevented The effect of tannic acid is to produce a firm, smooth, mahogany



Edward Martin

MEMOIR

EDWARD MARTIN

EDWARD MARTIN, the youngest son of Jonathan Willis and Malvina Register Martin, was born in Philadelphia on August 14, 1859. His preliminary education was obtained in the public schools of this city and for a short period at Central High School. He attended Swarthmore College four years, ranking first or second in all classes and obtaining Phi Beta Kappa. He graduated in 1878, *magna cum laude*, obtaining the degree of A B. at that time and later (1882) A M., and (1920) D Sc. from this College. He graduated from the medical school of the University of Pennsylvania in 1883 and served as assistant to Dr. D. Hayes Agnew and later to Dr. J. Wm. White. For a few years he practiced medicine and then devoted his time to the lines in which he ultimately specialized—genito-urinary and general surgery. He was a prolific writer, being the author of several authoritative textbooks on surgical subjects, sections for medical systems, editor of the University medical magazine and surgical editor of *The Therapeutic Gazette*, and as well he wrote innumerable papers which were read before various medical societies. He was a true teacher, with the ability so to present his thoughts as to impress them indelibly upon his listeners.

His loyalty and affection to Swarthmore College and the University of Pennsylvania were outstanding—nothing that he could do would ever be enough, in his estimation, to repay these two institutions for what they had done for him. He worked indefatigably for them in every way that he could. His motto was

'The best is yet to come' and with this in view he worked and planned to the last for work in the Edward Martin Biological Laboratory at Swarthmore, which laboratory was really a tribute to the lasting friendship existing between Mr. Fred M. Kirby and Dr. Martin, and made possible by Mr. Kirby's generous million dollar gift for this purpose.

Another permanent memorial to this friendship was the Kirby Fund, founded by Mr. Kirby for the benefit of students who needed financial aid to complete their medical course. It was instituted after Mr. Kirby heard Dr. Martin tell of a student who tried to work his way through medical college and died in the effort. Under this fund students were enabled to borrow such money as they required, paying it back to the fund as soon as they became able to do so. Dr. Martin helped financially and through his influence obtained scholarships for more than one young man—and these men have since achieved success in the medical and other professions, thanks to his effort and encouragement.

Dr. Martin was a pioneer in many lines—prior to the Wright Brothers' achievements, he and Dr. Paul Chamberlin conducted a number of experiments to prove

air flight possible. He also was interested in the Eastman Kodak films from a teaching standpoint and made several trips to the Eastman plant in the making of motion picture films—one of which dealt with appendicitis—to be used in the medical schools. He was a pioneer in the use of the lantern slide and later movie films for student teaching.

He was the first man in the University of Pennsylvania Hospital to use morphia after an abdominal operation and to Dr. Martin we owe the deep breathing exercises to prevent postoperative pulmonary complications, which practice has withstood the test of time and is today used even more commonly than is carbon dioxide. He early practiced the no touch or instrument technique in surgery using white cotton gloves as tell tales on the offender. Gentleness in the handling of tissue was his daily admonition.

In all things Dr. Martin believed in preparedness, and this, with his ideas on loyalty, honesty of purpose, kindliness, tactfulness and consideration in the handling of his patients, constituted his creed. He was honest with himself and others in all his dealings, a strict disciplinarian himself yet most charitable of the failings of others.

Dr. Martin had many allied activities in public enterprises. It was through his efforts that typhoid fever was stamped out during the Spanish American War; he was director of health and charities in Philadelphia under Mayor Weaver from 1903 to 1905; commissioner of health in Pennsylvania from 1918 to 1923 under Governor William Sproul (a classmate of his at Swarthmore); he inaugurated the traveling dental and prenatal clinics, did special work regarding syphilis and gonorrhea, instituted the use of toxin antitoxin for preschool age children and of antitoxin early in diphtheria, was responsible for schools of instruction held 1 week each summer for state inspectors. The Philadelphia Health Council and their good work against tuberculosis is the result of his efforts.

Since 1885 he was a member of the board of managers of Swarthmore College, a member of the board of education since 1911 and president at the time of his death. He was elected clinical professor of surgery of the Women's Medical College of Pennsylvania in 1902, resigning after several years. He was professor of clinical surgery at the University of Pennsylvania, 1903-1910, and John Rhea Barton professor of surgery at the same institution from 1910 to 1918. He also served the University of Pennsylvania as professor of surgical physiology. He was chief surgeon to the University of Pennsylvania and the Howard Hospitals, consulting surgeon to Bryn Mawr Hospital, Norristown State Hospital for the Insane, State Hospital for the Insane at Wernersville and the Philadelphia General Hospital.

He was a Fellow and Regent of the American College of Surgeons and the second president of the Clinical Congress of Surgeons of North America, a member of the American Philosophical Society, American Surgical Association, Society of

Endowed with a keen, quick sense of humor, Dr Martin with his 6 foot 1 inch straight soldierly carriage and dark auburn hair, was much in demand among his friends and professional colleagues, excelling alike as speaker, toastmaster or host—he was never at a loss for the appropriate word or expression in any situation. He was extraordinarily clever as a correspondent and always kindly, sympathetic, and helpful to those who were fortunate enough to come in contact with him. He was quick to sense any possible talent in those in whom he was interested and would do all in his power to bring such talent to perfection. The death of his wife last fall after many years of companionship was a great loss to him.

And so lived a great man—a true servant of the public—whose virtues often escaped the superficial observer as is true of so many of the world's kindest and most helpful members whose sincerity and naturalness leads them to hide their real selves behind a "smoke screen" to escape embarrassing acclaim. Of no one was this more true than of that Hicksite Quaker—Edward Martin.

E. L. ELIASON

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Clinical Surgery, American Association of Genito Urinary Surgeons, and of several foreign surgical societies, as well as the local state and county organizations Incidentally, he was a member of the Philadelphia County Medical Society for 54 years and received a framed certificate to that effect which he prized very highly In 1935 Temple University conferred on him the degree of Sc D

Dr Martin's war record covered a period of many years, he having been a Reserve Officer for some years and in the O R C several years before the World War His active service in the World War began in Philadelphia on January 1, 1918, although he had been a member of the Medical Section, Council of National Defense from the beginning of the war Dr Martin was lieutenant, major, lieutenant colonel, colonel, reserve officer of the World War—364th Medical Regiment, O R C, U S A, regimental and brigade surgeon Spanish American War, surgeon and major in Third Regiment National Guard of Pennsylvania for twelve years in the early '90s, director of School of Surgery, Fort Oglethorpe, Georgia also chief of surgical section of hospital He was the first director of Base Hospital No 20 of the University of Pennsylvania, however, he was soon called back to Washington, being succeeded by his assistant, Dr J B Carnett who carried it to its fruition Dr Martin was chairman of states committee—School of Surgery University of Pennsylvania, for medical officers of the Army director of professional service and surgical chief Walter Reed Hospital, chairman of states committee, Advisory Board, Medical Section Council of National Defense He was honorably discharged from the service on January 27, 1919

Athletics always aroused his greatest enthusiasm He was on a winning crew of the University of Pennsylvania in the '80s, played tennis fished, and in later years was an ardent golfer At the close of the football season he acted as host to the entire football squad of Swarthmore College, giving a traditional dinner at The Lamb's Tavern with the main feature on the menu a suckling pig with a red apple in its mouth

For a number of years beginning in 1903, Dr and Mrs Martin entertained children from the city slums at Valley Farm a short distance from their Orchard Farm These youngsters were exceptionally well cared for during their stay and were returned to their home after a vacation of a week or two, Girl Scouts have occupied a part of Dr Martin's farm for several years, his cousin presiding as hostess For the past 20 years Dr Martin spent his winters in Florida, his summers at Orchard Farm, Media Pennsylvania, and about a month at his home in Graefenburg Springs in the beautiful South Mountain part of the Blue Ridge chain There were many deer here and he planned to give this estate to the State as a game preserve after the death of Mrs Martin and himself

He was a member of the Jury Rittenhouse Pine Valley Golf, Rolling Green Golf and Seaview Golf Clubs

were successfully treated without amputation and that in any case there was every reason to attempt the salvage of the limb.

The seventh rule calls for amputation when a missile passing through a limb "denudes a large portion of the bone without fracturing it." After stating this condition as an indication it was advised that symptoms should be attentively considered before a decision for amputation is made. Mann says that cases of this character rarely require amputation and that always they should be "consecutive" (secondary) operations.

Larrey's eighth indication for primary amputation is a large opening by a cutting weapon into the larger joints, such as the knee or elbow. He gives as his reason the great liability to fatal infections. Mann considers that expectant treatment is warranted in these cases and cites instances of good recovery from such joint wounds.

In the axioms of Larrey the use of the terms "most prompt," "instantly," "immediately," and "without delay," in relation to battlefield amputations attracts attention. Without criticizing this feature of the great surgeon's dicta, Mann makes the observation, well confirmed by later experience, that a greater mortality followed early amputations than those which were deferred. His whole experience pointed to a conservative attitude in relation to indications for amputation and he was struck with the highly fatal results of such operations performed in haste under unfavorable conditions of weather and shelter. In his discussion of Larrey's indications for "consecutive" amputations, he appears to be in more agreement with that great authority.

Traumatic gangrene, it was agreed, demanded early amputation to forestall absorption of the

"deleterious principle." "Convulsive spasm of a wounded limb" is accepted as an absolute indication for its amputation, though Mann states that he encountered no case of tetanus during the war. An ununited compound fracture with continuing purulent discharge was a problem to be solved only by amputation. Mann reports excellent results in gunshot fractures of the femur from the use of the Desault splint, constructed for extension and counter-extension of the limb, and praised the modification devised by Dr. Philip Physick of Philadelphia.

"Bad state of the stump" is a general term for various conditions demanding reamputation. Mann agrees with Larrey that every means of treatment should be exhausted before reamputation is made.

It should be understood that while Mann was the medical advisor of the army commander he was also at all times in charge of a general hospital at army headquarters and always its chief operating surgeon. He thus had first-hand practical knowledge of the subject of which he writes. He was a contemporary of Baron Larrey, whose war experience and writing antedated Mann's by but a few years. While mainly deferring to Larrey's great authority, his attitude on indications for amputation was decidedly more conservative. In following this conservative bent he arrived by experience at the important conclusions that some delay was advantageous in a majority of cases, that by deferring amputation the operation was often found unnecessary and that amputations so deferred were attended by a lesser mortality.

Had these significant lessons been planted firmly in the mind of every medical officer it would not have been necessary to learn them anew, by bitter experience, in every succeeding war for the remainder of the century.

LANDMARKS IN SURGERY

SURGEON JAMES MANN, U S ARMY, OBSERVATIONS ON BATTLEFIELD AMPUTATIONS

JAMES M PHALEN M D Washington District of Columbia

JAMES MANN was born in Wrentham, Norfolk County Massachusetts, on July 3, 1759. Graduating with an arts degree from Harvard College in 1776 he studied medicine with Dr Samuel Danforth of Boston and on July 1 1779 was appointed surgeon of Colonel William Shepard's 4th Massachusetts Regiment in the Continental army. After the war he practiced medicine and surgery in Wrentham. At the time of Shays' Rebellion in western Massachusetts he was called to duty with the state militia. With the outbreak of the war with Britain in 1812 he was commissioned a surgeon in the regular forces and appointed medical director of the Northern Army under General Henry Dearborn. Until the appointment of James Tilton as Surgeon General in June 1813 Surgeon Mann was the senior medical officer in the service and remained in charge of the medical service in the field until the close of the war. Thereafter he served practically until his death in 1832 at Fort Independence in Boston Harbor. In 1819 he was appointed to the surgical staff of the Massachusetts General Hospital in succession to his old preceptor Dr Danforth. He became an influential and useful member of the state medical society. In 1822 he reported in the *Medical Repository of New York* a successful amputation at the elbow joint performed the previous year with favorable claims for joint amputations.

Following the close of the war Surgeon Mann prepared and published his *Medical Sketches of the Campaigns of 1812-13-14* (Dedham 1816) which constitutes the principal source of information in regard to the medical history of the War of 1812. It covers the operations of the Northern Army in considerable detail with observations upon the topography of the area of combat. Much of the medical section is devoted to the discussion of dysentery pneumonia and the ill identified fevers which plagued the army. It is of interest to note that he advocated the use of ipecac in the treatment of dysentery.

The section devoted to surgery is mainly given over to the pronouncements of Baron Larrey in his *Mémoires de Chirurgie Militaire* (Paris 1812) on the indications for primary and secondary amputations in battle casualties and their evaluation in the light of his experience in the late war. Though in the main in agreement with Larrey's dicta and citing case reports in their support he dissents sharply from certain of the great Frenchman's arbitrary rules and

finds many exceptions in his indications for mandatory amputation.

Taking up Larrey's axioms serially he agrees that "when a limb is carried away by a ball by the bursting of a grenade or a bomb the most prompt amputation is necessary. He agrees also that 'when a body is projected from a cannon and strikes a limb so that the bones are fractured and the soft parts violently contused, extensively torn and broken up amputation should be instantly performed.' Larrey's third proposition that 'when a large portion of the soft parts and the principal vessels of a limb are carried away by a ball and the bone fractured amputation should be immediately performed' also meets with his approval.

The capture of Little York (Toronto) by General Dearborn's army in April 1813 was attended by the explosion of the enemy's powder magazine which produced scores of frightfully mutilating wounds among the American forces. Conditions for treatment of these casualties were highly unfavorable and Mann tells of the disastrous results of amputations too long delayed. On the other hand he speaks of fortunate results attending early amputation in cases of similar character.

Larrey's fourth rule says that 'when a large ball strikes a thick part of a limb breaks the bone cuts and tears the muscles destroys the great nerves and yet leaves the principal artery entire immediate amputation should be resorted to.' Mann dissents from unqualified acceptance of this rule and cites cases in which not only life but fairly useful limbs were saved.

The fifth rule pertains to the effects of a spent missile which without breaking the skin produces more or less damage to the underlying tissues. Bones may be broken muscles shattered and blood vessels cut off. Mann agrees with Larrey's dictum that the necessity for amputation must depend upon a determination of the site and nature of the deep traumatism. It was agreed that an incision was indicated for this purpose and for drainage of any hematoma.

Larrey's sixth indication relates to the injury caused by a missile which has fractured the orbital extremities more particularly those which form the knee or the ankle joint and when the ligaments which surround these articulations have been torn or broken up. Mann dissents strongly from the necessity for amputation in these cases and states that numerous instances of musket ball wounds of joints

THE term "disruptive chemiotaxis" has been coined by Bertwistle in his recent book¹ to express the power of certain hard substances (bone) of attracting and drawing into themselves certain soft, living structures. An example would be the attraction of the earth and its moisture for roots as seen in the study of the germinating seed.

The chapters dealing with the histology and development of bone contain the standard text on bone growth and are concise and clear. The author then lays down the following law: Whenever young fibrous tissue, particularly young blood vessels, is in contact with bone or a calcium deposit, bone will form. The question of periosteal bone generation is discussed. Evidence of each school of thought is presented. The author believes that the periosteum is capable of producing bone according to the law stated. This is illustrated by the fracture in which we have hemorrhage about the bone ends, the cells in the vicinity die leaving a calcified deposit which is invaded by fibrous tissue cells, becoming bone cells. The problem of ectopic bone formation is presented. Original evidence is lacking to either confirm or negate the proposed theories except that disruptive chemiotaxis may account for the invasion of calcified material by young blood vessels. The object of the book is to present this viewpoint.

LEON J. ARIES

IT SHOULD be respectfully noted that with the withdrawal of Sir Robert Muir from active participation, the original authorship of the book, *Muir and Ritchie's Manual of Bacteriology*,² which was first published in 1897, has come to an end. Detailed review of this well known standard English text is quite unnecessary. Suffice to state that the present writers, alert to the recent advances in the subject, have brought the book up to date and maintain the spirit and high character of the previous editions. However, it is again remarked that the small type employed and the narrow inner page margin, together with the tight binding, interfere with ease of perusal.

A. A. DAY

FREIBURG is one of the centers of research in endocrinology. The relatively brief monograph, *Innere Sekretion und Chirurgie*,³ from the Surgical Department there reviews the physiology of the glands of internal secretion, outlines very briefly the diseases of these glands, and mentions the surgical indications for their hormones. The section on each gland is followed by a bibliography of considerable extent. The discussion of such subjects as the pre-operative iodine remission of hyperthyroidism, or the postoperative management of parathyroid tetany is inadequate. Nevertheless, the book

furnishes a starting point and represents much German work and practice in this field.

PAUL STARR.

ALTHOUGH the first edition of Hamilton Bailey's *A Physical Signs in Clinical Surgery*⁴ was published in 1927, we in America have failed to recognize the full import of this splendid book. The present volume, the sixth of its kind, is even more valuable. Short, containing but 284 pages, it reads like a story book. Within these pages are contained 334 photographs, many in color. These colored plates are perhaps the most beautiful it has been my pleasure to find in any medical work.

The story behind Bailey's book can best be given in the author's own words, taken from the preface to previous editions, in which he states.

There is a growing tendency to rely on laboratory and other auxiliary reports for a diagnosis. A former chief was wont to picture the modern graduate of medicine, when summoned to an urgent call, driving up to the patient's house followed by a pantechucon containing a fully equipped X-ray installation, and a laboratory with a staff of assistants. Without these aids the future doctor would be unable to formulate a diagnosis. The history, and physical methods of examination, must always remain the main channels by which a diagnosis is made.

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EARLE I. GRFENE

¹THE RÔLE OF CHEMIOTAXIS IN BONE GROWTH. By A. P. Bertwistle, M.B., Ch.B., F.R.C.S. (Edin.) London: Henry Kimpton, 1937.

²MUIR AND RITCHIE'S MANUAL OF BACTERIOLOGY. Revised by Carl H. Bowman, M.D., LL.D., D.P.H., F.R.S., and Thomas J. Mackie, M.D., D.P.H. 10th ed. London: Oxford University Press, 1937.

³INNERE SEKRETION UND CHIRURGIE. By Hans Hanke. Berlin: Julius Springer, 1937.

⁴DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.) 6th rev. ed. Baltimore: William Wood & Co., 1937.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN THE field of diseases of the lung one of the striking developments during the past two decades has been the marked increase in the incidence of carcinoma of the bronchus. From being a rare disease it has come to be exceedingly common and has accordingly, attracted a great deal of attention and been the subject of a great number of articles. Numerous points of discussion have arisen concerning the increase in incidence, the pathology and the treatment. *Primary Carcinoma of the Lung* by Simons is a careful review of a very extensive literature and for that reason is exceedingly valuable. This is not the first book on this subject but is the most recent and most complete. For any one working in this field who has not had time to read every thing written it should provide a satisfactory shortcut.

JEROME R. HEAD

IN THIS present day of growing interest and understanding concerning the autonomic nervous system it requires no small amount of courage to undertake the task which Gask and Ross have so well handled in this, the second edition of their successful work first published in 1933, *The Surgery of the Sympathetic Nervous System*.¹ The authors forewarn the reader that they do not intend to compile a complete record of all the conditions which are today being treated by sympathectomy and their discussion covers only surgery of the thoracolumbar portion of the autonomic nervous system. They have deliberately omitted any treatment of the subjects of *retinitis pigmentosa*, *hyperhidrosis*, *hypertension* and *bronchial asthma*.

The section dealing with circulatory disease and particularly with *Raynaud's disease* is an especially enlightening one and the authors apparently have had a wide experience in the surgical treatment of these conditions. They stress the importance of an exhaustive pre-operative study to select cases suitable for surgery and they look with definite favor on such treatment but here as elsewhere in their book they are conservative and restrained from overinterpretation of their experiences and from overenthusiasm for their own results. They take a very definite stand in favor of the *periarterial sympathectomy* operation of *Leriche* properly applied.

The plan of the book is pleasingly simple and direct and it is based entirely on a careful study of the authors' own cases. The section on the anatomy and physiology of the sympathetic nervous system

is clear, concise, and free of theorizing; ambiguous statements yet accuracy is not at all sacrificed. There are sections on (a) sympathectomy for disorders of the circulation, (b) sympathectomy for disorders of the visceral motor mechanism (gastro-intestinal and urinary tracts), and (c) sympathectomy for pain that is visceral pain and *causalgia*. The illustrations, while not profuse, are adequate.

JOSEF MARTIN

THIS monograph² by Mackee and Cipollaro was prepared with the idea of reducing the mortality from accessible cancer. It was written not only for general practitioners but for all physicians interested in the cancer problem.

This type of monograph was badly needed and the publishers are to be congratulated not only for seeing the need of such a work but for their choice of authors. No one is better able to write such a book than Mackee with his long years of clinical experience in dermatology and radiotherapy.

The work is divided into four chapters: (1) a few pages dealing with the morbidity and mortality of cutaneous cancer, (2) the precancerous dermatoses. Twenty different dermatoses of precancerous character are briefly but fully described in this chapter, (3) carcinoma and sarcoma, (4) established therapeutic methods.

The monograph is not long. There are only 222 pages of reading matter but in this short volume is packed a fund of valuable information. Each subject is handled in such a clear, concise manner that it is an extremely easy book to read. As the aim of the work is entirely practical many question and theoretical matters are omitted. On the subject of treatment the authors have not attempted to describe in minute detail therapeutic measures but have simply indicated the recommended form of treatment.

There are 231 splendid illustrations—photographs of cutaneous lesions and photomicrographs.

There is an extensive bibliography at the end of each chapter. The book is printed on good paper in clear legible type.

The authors have attempted to present the symptomatology, diagnosis, etiology, pathology, and treatment of precancer and cancer of the skin and mucosa as concisely and clearly as possible. In that they have succeeded admirably. This book should be added to the library of every practicing physician. It is a splendid work.

F. A. OLIVER

¹ PRIMARY CARCINOMA OF THE LUNG. By Edwin J. Simons. M.D. Ch.C. 20. The Year Book Publishers, Inc. 1937.

² THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Mackee, M.D., D.S.O., F.R.C.S. (E.G.) and J. P. Cipollaro, M.D., F.R.C.S. (E.G.). 2nd ed. Baillière Tindall & Co. 1937.

CUTANEOUS CANCER. BY GEORGE E. MACKEE, M.D. AND JOSEF CIPOLLARO, M.D. NEW YORK: THE AMERICAN JOURNAL OF CANCER 1937.

THE term "disruptive chemiotaxis" has been coined by Bertwistle in his recent book¹ to express the power of certain hard substances (bone) of attracting and drawing into themselves certain soft, living structures. An example would be the attraction of the earth and its moisture for roots as seen in the study of the germinating seed.

The chapters dealing with the histology and development of bone contain the standard text on bone growth and are concise and clear. The author then lays down the following law: Whenever young fibrous tissue, particularly young blood vessels, is in contact with bone or a calcium deposit, bone will form. The question of periosteal bone generation is discussed. Evidence of each school of thought is presented. The author believes that the periosteum is capable of producing bone according to the law stated. This is illustrated by the fracture in which we have hemorrhage about the bone ends, the cells in the vicinity die leaving a calcified deposit which is invaded by fibrous tissue cells, becoming bone cells. The problem of ectopic bone formation is presented. Original evidence is lacking to either confirm or negate the proposed theories except that disruptive chemiotaxis may account for the invasion of calcified material by young blood vessels. The object of the book is to present this viewpoint.

LEON J. ARIES.

IT SHOULD be respectfully noted that with the withdrawal of Sir Robert Muir from active participation, the original authorship of the book, *Muir and Ritchie's Manual of Bacteriology*,² which was first published in 1897, has come to an end. Detailed review of this well known standard English text is quite unnecessary. Suffice to state that the present writers, alert to the recent advances in the subject, have brought the book up to date and maintain the spirit and high character of the previous editions. However, it is again remarked that the small type employed and the narrow inner page margin, together with the tight binding, interfere with ease of perusal.

A. A. DAY.

FREIBURG is one of the centers of research in endocrinology. The relatively brief monograph, *Innere Sekretion und Chirurgie*,³ from the Surgical Department there reviews the physiology of the glands of internal secretion, outlines very briefly the diseases of these glands, and mentions the surgical indications for their hormones. The section on each gland is followed by a bibliography of considerable extent. The discussion of such subjects as the pre-operative iodine remission of hyperthyroidism, or the postoperative management of parathyroid tetany is inadequate. Nevertheless, the book

furnishes a starting point and represents much German work and practice in this field.

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BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as page permits.

HOW ANCIENT HEALING GOVERNS MODERN THERAPEUTICS. THE CONTRIBUTION OF HELLENIC SCIENCE TO MODERN MEDICINE AND SCIENTIFIC PROGRESS. By Kleanthes A. Ligeros. M.D. Ph.D. New York and London: C. P. Putnam & Son, 1937.

CLÍNICA Y TERAPÉUTICA QUIRÚRGICAS DE LEGENCIA. By M. Corachán García and F. Doménech Alsina. Barcelona: Madrid: Buenos Aires: Rio de Janeiro: Editorial Labor S.A., 1937.

INTRODUCTION TO OPHTHALMOLOGY. By Peter C. Kronfeld. M.D. Springfield, Ill.: Charles C. Thomas, 1938.

A SYMPOSIUM ON CANCER. GIVEN AT AN INSTITUTE ON CANCER CONDUCTED BY THE MEDICAL SCHOOL OF THE UNIVERSITY OF WISCONSIN. Madison: The University of Wisconsin Press, 1938.

CLINICAL ROENTGEN THERAPY. Edited by Ernst A. Lohle, M.D., Ph.D. F.A.C.R. Foreword by George W. Holmes, M.D. Philadelphia: Lea & Febiger, 1938.

TREIZE COUPES HORLOGEES DE THORAX. By A. Hovelacque, Olivier Monod, Henri Evtard. Drawings by Arnold Moreaux. Paris: Librairie Maloine, 1938.

MEN LAST FORTY. By A. F. Niemoeller. A.B. M.A. B.S. With a foreword by Winfield Scott Fugh. B.S. M.D. New York: Harvest House, 1938.

THE FIGHT FOR LIFE. By Paul de Kruif. New York: Harcourt Brace & Co., 1938.

A CHALLENGE TO SEX CENSORS. By Theodore Schroeder. New York, 1938.

HEMORRHOIDS. By Marion C. Pruitt. M.D. L.R.C.P. S. (Ed.). St. Louis: The C. V. Mosby Co., 1938.

NEURO-OPHTHALMOLOGY. By R. Lindsay Rea. B.Sc. M.Ch., F.R.C.S. St. Louis: The C. V. Mosby Co., 1938.

THE HEART IN PREGNANCY. By Julius Jensen. St. Louis: The C. V. Mosby Co., 1938.

SYMPTOMS OF VISCERAL DYSFASIA. A STUDY OF THE VEGETATIVE NERVOUS SYSTEM, etc. By Francis Marion Pottinger. A.M. M.D. LL.D. F.A.C.P. 5th ed. St. Louis: The C. V. Mosby Co., 1938.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 62 for the year 1937. Edited by Richard W. Telinde. M.D. St. Louis: The C. V. Mosby Co., 1938.

O PROBLEMA DA LUXAÇÃO CONGENITA DO QUADRIL NO BRASIL. By Dr. Rezende Puch. São Paulo: Brazil: Imprensa Gráfica da Revista dos Tribunais, 1937.

LAS NEUMECTOMIAS TOTALES. By Jorge A. Galante. Buenos Aires: Editor El Ateneo, 1937.

OXFORD MEDICAL PUBLICATIONS. HISTOLOGICAL TECHNIQUE FOR NORMAL TISSUES, MORBID CHANGES AND THE IDENTIFICATION OF PARASITES. By H. M. Carter. M.A. B.Sc. D.Phil. and E. H. Leach. M.A., B.Sc. Chapters I and VII in collaboration with Frederic Haynes. M.A. 2nd ed. London: New York: Toronto: Oxford University Press, 1938.

THORACIC SURGERY. A revised and abridged edition of Sauerbruch's *Die Chirurgie der Brustorgane*. By Ferdinand Sauerbruch and Laurence O'Shaughnessy. F.R.C.S. Baltimore: William Wood & Co., 1937.

NATIONAL MEDICAL MONOGRAPHS. FRACTURES AND DISLOCATIONS. Vols. 1 and 2. By Philip Lewis. B.S. M.D. Edited by Morris Fishbein. M.D. New York: National Medical Book Co. Inc., 1937.

ATHLETIC INJURIES. PREVENTION, DIAGNOSIS AND TREATMENT. By Augustus Thorndike, Jr. A.D. Philadelphia: Lea & Febiger, 1938.

A PRACTICAL GUIDE TO MASSAGE. By C. Irene Carpenter. With introduction by David Katz. Ph.D. Baltimore: William Wood & Co., 1937.

MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SPECIAL CONDITIONS. By Noel M. Tidy. 3d ed. Baltimore: William Wood & Co., 1937.

PEDIATRIC SURGERY. By Edward C. Brenner. A.B. M.D. F.A.C.S. Philadelphia: Lea & Febiger, 1938.

PROGRESSIVE RELAXATION, A PHYSIOLOGICAL AND LITICAL INVESTIGATION OF MUSCULAR STATES AND THEIR SIGNIFICANCE IN PSYCHOLOGY AND MEDICAL PRACTICE. By Edmund Jacobson. A.M., Ph.D., M.D. 2nd ed. Chicago, Ill.: The University of Chicago Press, 1938.

ESSENTIALS OF OBSTETRICAL AND GYNECOLOGICAL PATHOLOGY WITH CLINICAL CORRELATION. By Maxon Douglas. M.D. F.A.C.S. and Robert L. Faulkner. M.D. St. Louis: The C. V. Mosby Co., 1938.

CORRESPONDENCE

AMERICAN CONGRESS OF OBSTETRICS AND GYNECOLOGY

SEVERAL meetings have been held by the members and directors of the American Committee on Maternal Welfare Inc. to develop the arrangements for convening the Congress in Cleveland, Ohio during the week of September 11, 1939.

The Congress has been organized to include the interests of medical educators, physicians, nurses, public health workers, hospital administrators and

others interested in the problems of human reproduction.

Morning sessions will be devoted to the presentation of scientific and technical papers. In the afternoons general discussions will be held and the evening sessions will be open to the public.

All inquiries should be directed to the general chairman of the Congress, Dr. Fred L. Adair, whose executive office is at the Annex of the American College of Surgeons, 650 Rush Street, Chicago, Illinois.

AMERICAN COLLEGE OF SURGEONS

GRADUATE TRAINING FOR SURGERY—GENERAL SURGERY AND THE SURGICAL SPECIALTIES

DALLAS B. PHEMISTER, M.D., F.A.C.S., Chicago, Illinois

FOR 25 years the American College of Surgeons has pursued its objective—to advance the science of surgery and to insure the competent practice of its art. During those years the knowledge on which the science of surgery is based has been greatly broadened and the techniques on which the art of surgery depends have steadily become more intricate and varied. In line with progress, the College has concerned itself with the lengthening and strengthening of preparatory study and training for doctors who aspire to a surgical career, in order to assure the patient of service which is commensurate with the latest and best practice.

The advancement of surgery is dependent upon better trained surgeons. A year's internship following graduation from medical school does not provide training sufficient to equip the doctor to perform surgery independent of supervision. His knowledge of theory and his observation of procedures should be supplemented by skill and good judgment acquired firsthand but under experienced eyes. Otherwise the life of the patient is endangered.

The American College of Surgeons, as it begins its second quarter century of service, commits itself to a thorough, systematic, and determined effort to advance graduate training for surgery. Only through such an effort can it continue to fulfill its obligation to the profession and to the public—to protect the patient from incompetent surgery. Graduate training is not merely a classroom or laboratory function and should not be confused with postgraduate study which means the pursuit of an already acquired training in a specialty.

It is important, first, to say that the fault does not lie with many recent graduates who must acquire their experience unguided. Not from them will complaint be heard when extension of the training period becomes the rule rather than the exception. They have proved themselves eager for opportunities to gain thorough training, but

corresponding eagerness has not been shown heretofore in providing such opportunities for them.

The College is taking into consideration the impressive fact that there were in existence in 1937 only 164 hospitals approved by the American Medical Association for residencies in general surgery; 292 hospitals were approved for residencies in the surgical specialties. These hospitals accommodated 580 residents in general surgery and 910 in the surgical specialties. The figures, of course, do not represent the number of residencies available each year, since some of the appointments are for periods of from 15 months to more than 3 years. It is therefore quite generally conceded that if thoroughly trained surgeons are to be supplied in sufficient numbers, more opportunities for graduate training must be provided. Hospitals which offer residencies are deluged with applications. Failing of acceptance in these, the graduate seizes a lesser opportunity where he can, but he is likely to be among the large group who are faced with the discouraging fact that there are for them no supervised training facilities. Sometimes, like his predecessors of an earlier era, the graduate is fortunate enough to become associated with an older and experienced surgeon who will supervise his work. The training of a surgeon, however, should not be left to chance.

The College began its study of graduate training for surgery in 1930. Four years later a committee was formed under the chairmanship of Dr. Samuel C. Harvey of New Haven, Connecticut, who submitted his report at the annual meeting of the College in San Francisco in October, 1935, recommending that "in conjunction with the development of a program for graduate training for surgery a re-study be made of the requirements for admission to fellowship in the College." Since that time the College has been surveying the possibilities for graduate training, and following the particularly broad investigation conducted by its special field representatives in 1937, the results of which are published in the *Bulletin* for January, 1938, it is ready to state authoritatively that it is

upon hospitals not controlled by medical schools that effort must be concentrated. Most medical school hospitals are providing excellent training—but naturally they cannot undertake to train all the surgeons who are needed.

To quote from the report of the College survey:

'Residencies in selected hospitals afford the broadest opportunities for training a larger number of surgeons or rather for the more thorough training of a larger number. Any plan for the extension of residencies into this group of hospitals should take into consideration the fact that graduate training for general surgery and the surgical specialties necessitates a carefully directed and supervised apprenticeship in which the graduate actually participates in practical surgical work. Consideration should also be given to the facilities for further study of the fundamental sciences of anatomy, physiology and pathology as well as for the acquisition of a detailed knowledge of the past and current literature of surgery. This implies more affiliations with medical schools and more co-operative effort in graduate training programs.

The 1937 report of survey by the American College of Surgeons was based on 140 selected hospitals of all types which present facilities for graduate training in general surgery and the surgical specialties. The purpose was to obtain detailed information regarding the duration and quality of training being given in various hospitals. Valuable data were gathered. It was discovered that "there exists no basic standard of uniformity in the methods of graduate training" to quote the language of the report which goes on to say 'This lack of uniformity is not sectional or provincial for even in the same cities there is this heterogeneity of methods and opinion regarding courses of training. It was also found that 'a few of the best planned and best functioning surgical residencies are in non university connected hospitals' which should be encouraging to the hospital that has hesitated to establish residencies because it is not a so-called "teaching hospital."

As the result of an analysis by Dr. Malcolm T. MacEachern and his associates of information gathered by the College, there were formulated "Criteria for Graduate Training for Surgery" supplemented by a "Manual of Graduate Training for Surgery." The manual is the first concrete help that is being offered to the groups upon whom will fall the responsibility for extending more and better opportunities for graduate training.

The magnitude and importance of any program in graduate training for surgery may be judged from the fact that more than 2,500,000 operations are performed in the United States and Canada annually by some 35,000 doctors many doing only the limited surgery of their general practice.

The experience of the College in promoting Hospital Standardization has qualified it for lead-

ership in interesting a greater number of approved hospitals to provide acceptable graduate training. Three competent, long experienced officers of the College are engaged this year in carefully noting and recording the respects in which those hospitals having residents are meeting the criteria and the extent of the adjustments others would have to make to establish graduate training facilities that could be approved under this standard. Three hundred and eighty six hospitals are included in the 1938 survey. The complete, detailed reports are being reviewed by the following Committee on Graduate Training for Surgery, which will determine the hospitals that are now qualified to accept responsibility for graduate training in general surgery and the surgical specialties:

Dallas B. Phemister, Chicago, Chairman
Donald C. Balfour, Rochester, Minnesota
John R. Fraser, Montreal
Albert C. Fuestenberg, Ann Arbor
Harry S. Gradle, Chicago
Everts A. Graham, St. Louis
Howard C. Naffziger, San Francisco
Gilbert J. Thomas, Minneapolis
Allen O. Whipple, New York
Philip D. Wilson, New York

The committee will submit in October a report in which will be listed the hospitals which are meeting the criteria and also those hospitals which with minor adaptations could do so. Periodic surveys will be made to ascertain whether the minimum standard for such training is being adhered to.

Acting on the recommendation of the original Committee on Graduate Training for Surgery, the Board of Regents of the College at a meeting on May 10, 1936, raised the requirements for fellowship as stated in the following extract from the minutes of that date:

BE IT RESOLVED that applicants for fellowship whose qualifying medical degree shall have been obtained after the date of January 1, 1938, shall be required to present evidence of having completed 3 years of hospital service in one or more acceptable hospitals of which 2 years shall have been spent in training in surgery in hospitals approved by the American College of Surgeons. In the case of graduates of medical schools which withhold the medical degree until after a fifth year of hospital internship the date set will be January 1, 1939.

In justice to all who aspire to future fellowship in the College there must be assurance that no qualified man shall lack the opportunity to obtain the graduate training required for there is no desire to set the requirements so high that they cannot be met. As the standard for fellowship goes up so must the standard for the profession itself be raised. This can be accomplished best at the present time by winning hospital support for wider graduate training opportunities.

SUBJECT INDEX TO VOLUME 66

- ABDOMEN**, New McDonald's solution, 246; Disturbances of blood and lymph circulation of, 322, Abdominal and pelvic pain—from gynecological viewpoint, 432, Injuries of chest and, 448
- Abnormalities**, Congenital anomalies of rectum and anus, 11, Uterus bicornis duplex associated with infection due to micro-aerophilic hemolytic streptococcus, 117, Pilonidal cysts, 231
- Accidents**, first aid, Injuries of chest and abdomen, 448
- Acetonuria**, Study of hyperemesis gravidarum with special reference to blood chemistry, 858
- Air**, lead content of, Recognition and prevention of lead poisoning, 444
- Albee**, spine fusion operation in treatment of scoliosis, 797
- Ambulatory operative treatment of anorectal pathological disease**, 1054
- American Academy of Arts and Sciences**, Francis Amory Septennial Prize of, cor 818
- American Board of Obstetrics**, Radical obstetrics and national maternal mortality, 423
- American Board of Surgery**, College and cultural aspects of surgery, 414
- American College of Surgeons**—
Address of retiring president, College and cultural aspects of surgery, 414
- Cancer**, Symposium on, 512-560
- Clinical Congress**, Transactions 1937, Chicago, 257-562, Notes on 1937 meeting, 419, 1938, in New York and Brooklyn, 945
- Committee on Industrial Medicine and Traumatic Surgery**, 443
- Conference on Traumatic Surgery**, 443-478
- Fellowship requirements**, College and cultural aspects of surgery, 414
- Fracture Symposium**, 479-511
- Graduate training for surgery**—general surgery and surgical specialties, 1077
- Hospital standardization**, conference, 20 years of, 421
- Obstetrics and Gynecology**, Symposium on, 423-442
- Oration in surgery**, Surgeon as a biologist, 257
- American Committee on Maternal Welfare**, American Congress on Obstetrics and Gynecology, cor 1076
- Amory**, Francis, Septennial prize, of American Academy of Arts and Sciences, cor 818
- Amputations**, Surgeon James Mann, U S Army, observations on battlefield amputations, 1072
- Amyl nitrite**, Relation of spasm of second portion of duodenum to biliary colic, 979
- Analgesia**, Conduction, in anorectal surgery, 105, Obstetric anesthesia I. Laboratory method for studying effects of anesthetic and analgesic agents on both uterus and fetus, 179
- Anesthesia**, Obstetric, I. Laboratory method for studying effects of anesthetic and analgesic agents on both uterus and fetus, 179, Evipal soluble, basal, 227, Ether, ed 935, Ambulatory operative treatment of anorectal pathology, 104 consecutive operations performed under local, of prolonged duration, 1054
- Antisepsis**, Antiseptic era, ed 685
- Antrum**, Infections of paranasal sinuses of dental origin, 408
- Anus**, Congenital anomalies of rectum and anus, 11, Conduction analgesia in anorectal surgery, 105, Ambulatory operative treatment of anorectal pathology, 104 consecutive operations performed under local anesthesia of prolonged duration, 1054
- Appendix**, Thrombophlebitis of appendicular vein complicating acute appendicitis, 62, Study of appendicitis, analysis of 1,463 consecutive cases, 166; Induced spreading peritonitis complicating acute perforative appendicitis, 947, Acute appendicitis in children, 962, Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study, 975
- Arm splints**, Fractures of shaft of humerus, 482
- Arthritis**, rheumatoid, gonorrheal, Surgical fusion of wrist joint, 1008
- Artery**, thyroid, Routine dissection and demonstration recurrent laryngeal nerve in subtotal thyroidectomy, 775
- Asphyxia**, Mechanical resuscitation in advanced forms of asphyxia, clinical and experimental study in different methods of resuscitation, 698
- BACK**, low, pain, Lesions of intervertebral disc and ligamenta flava, clinical and anatomical studies, 288; Treatment of low, pain due to functional decompensation, 1032
- Bacteria**, Bacterial species found in non-sterile surgical catgut sutures, 878
- Beaumont**, William, Three, letters, 125
- Benzpyrene**, Effect of light on, cancer in mice, 989
- Bile**, Experimental cholecystitis, 748
- Bile duct**, common, Instrumental dilatation of papilla of Vater, experimental and clinical observations, 100
- Biliary disease**, in young subjects, 604
- Biliary tract**, Acute pancreatitis, 348, Surgical procedures for biliary calculi, 637, Cholangiographic demonstration of remaining common duct stone and its non-operative management, 1040
- Biologist**, Surgeon as, 257
- Birth palsy**, Obstetrical shoulder trauma, 868
- Bladder**, Interposition operation with sterilization, 88, Tuberculosis of kidney, 329, Some physiological and pathological observations on urinary tract during pregnancy, 360, Cystectomy and transplantation of ureters into bowel for carcinoma of, 549, Aseptic uretero-intestinal anastomosis, 657, Operative injuries of ureter, 790, Transvesical diathermy in treatment of carcinoma of, 927, Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study, 975, Management of, tumors, 999, Correction of cystocele and rectocele in process of supravaginal hysterectomy, 1038
- Blood**, circulation of, Concerning term "shock," ed 123, transfusion of, Inexhaustible source of, for, and its preservation, preliminary report, 176, circulation of, Disturbance of, and lymph circulation of abdomen, 322
- Blood chemistry**, Study of hyperemesis gravidarum with special reference to, 858
- Blood stream**, Visceral metastasis for rectal carcinoma, 611
- Blood urea**, Concentration of serum sulphate and, in prostatic hypertrophy associated with urinary obstruction, 994
- Blood vessels**, Thrombophlebitis of appendicular vein complicating acute appendicitis, 62, Thrombophlebitis of varicose veins, 236, Disturbances of blood and lymph circulation of abdomen, 322, Malignant adenoma of thyroid, local recurrences in veins of neck, 577
- Bone**, Use of os purum in implantations, with special reference to its use in tuberculous, and joint lesions, 23, Biological surgery in tuberculous patients, 55, repair of, Relation of cartilage to, 173, temporal, Surgical

- treatment of various type of lesion in petrosal pyramid 395
- Bone atrophy Functional disabilities after simple fracture, with special reference to importance of, in prolongation of disability, 459
- Bone plates and screws Present status of operative treatment of fractures 353
- Brain Primary fibroblastic tumors of choroid plexus of lateral ventricles clinicopathological study of 3 cases 804
- Breast Relation of chronic cystic mastitis to carcinoma of 300 Paget's disease of nipple 535
- Bronchus Carcinoma of clinical and pathological study of 164 cases 902
- Buccal mucosa Epidermoid carcinoma of 810
- Burns Hallux valgus 95 889
- Burns Vitamin oil in treatment of experimental study 622 Modern treatment of ed 1064 ed 1065

CALCIUM chloride Intravenous and its use for relief of visceral colic clinical and experimental study 975

Cancer Concerning hereditary nature of ed 247, Symposium on Correlation of body segmental temperature and its relation to location of carcinomatous metastasis clinical observations and response to methods of refrigeration 512 Third International Congress for 600 group study of Carcinoma of rectum pleura for and treatment 760 Far Effect of light on benzpyrene in mice 939

- Carcinoma potential Non invasive of cervix 822
- Care postoperative Induced spreading peritonitis complicated by acute perforative appendicitis 947 Acute appendicitis in children 962
- Cartilage Relation of to repair of bone 173
- Catgut Relation of sensitivity to wound healing, 628 Bacterial species found in non sterile surgical 878
- Cell Hurtle tumor of thyroid gland 1
- Cesarean section 437
- Cheilitis Macrocheilia due to hyperplasia of labial salivary glands operative correction 1024
- Chest Injuries of and abdomen 448
- Childbirth Retraction ring dystocia its cause and correction 1047
- Children Biliary disease in young subjects 624 Acute appendicitis in 962
- Children's bureau Federal Government Radical obstetrics and national maternal mortality 423
- China Trachoma situation in 339
- Cholangiography Cholangiographic demonstration of remaining common duct stone and its non-operative management 1040
- Cholecystectomy Surgical procedures for biliary calculi 637
- Cholecystitis Experimental 748
- Cholangiography Rate of emptying of human gall bladder in pregnancy 145
- Cholecystostomy Surgical procedures for biliary calculi 637
- Cholelithostomy Surgical procedures for biliary calculi 637
- Choroid plexus Primary fibroblastic tumors of lateral ventricles clinicopathological study of 3 cases 804
- Circulation studies on in pregnancy II Vital capacity observations in normal pregnant women 391
- Colles fracture Malunited fractures 460
- Colon Krusenbergs tumors of ovary clinical and pathological study of 21 cases 157 Segmental enteritis, 215 Operability in cancer of rectum 925
- Common duct Cholangiographic demonstration of remaining stone and its non-operative management 1040

- Compensation costs Modern concept of industrial medical problem 454
- Conception Fertile period in practice five year clinical study 723
- Corpus uterum Methods of demonstration, activity of 732
- Culture College and cultural aspects of surgery, 454
- Cystocoele Interposition operation with sterilization 8

- D**ECOMPENSATION functional Treatment of low back pain due to 1032
- Denmark Some Scandinavian clinics ed 933
- Diabetes and pregnancy 37
- Diathermy Transvesical in treatment of carcinoma of bladder 917 surgical Electrosurgery ed 245
- Diet, Value of determinations of protein prior to operations on gastro intestinal tract ed 634
- Disability Functional after simple fracture with special reference to importance of bone atrophy in prolongation of 489
- Disc, intervertebral Lesions of, and ligamenta flava clinical and anatomical studies 233
- Disease Pott's Biological surgery in tuberculous patients 55, Bowen's dermatosis Clinical behavior of early carcinoma of cervix 129, Schimmelbusch Relation of chronic cystic mastitis to carcinoma of breast 300 Paget's disease of nipple 535
- Disinfection New McDonald's solution 246
- Diverticula, of intestine 314
- Duodenum Treatment of peptic ulcer—indications for surgery, 64 Technical surgical procedures for gastric and duodenal ulcer 269 Extent and character of peptic ulcer and gastroduodenitis in different countries 566 Relation of spasm of second portion of to biliary colic 929
- Dystocia Retraction ring its cause and correction 1047

- E**AR Surgical treatment of various types of lesions in petrosal pyramid 395 Malignant neoplasms of nasopharynx 400 Complications to avulsion of scalp and loss of right reconstruction by pedunculated tube grafts and costal cartilage 459
- Early American Medical Schools Historical sketch of Jefferson Medical College 940
- Eclampsia Water balance in relation to toxemias of pregnancy 420
- Electrosurgery ed 245
- Enteritis Segmental 215
- Esophagus Surgical treatment of carcinoma of thoracic with report of 3 success ful cases 534
- Ether anesthesia ed 935
- Evipal soluble basal anesthesia 227
- Eye Modern surgery of retinal detachment 340 Some principles involved in surgery of extra-ocular muscles 383, Trachoma situation in China 389

- F**ACE Macrocheilia due to hyperplasia of labial salivary glands operative correction 1024
- Famous autographs 3 Doctors Willam Beaumont letters, 124 Dr Valerius de Mott op 253
- Famous portraits Sir James Paget op 129 Sir William Jenner op 691
- Fascia transversalis Inguinal hernia 1 Anatomy of region 186
- Femur Malunited fractures 460 Two phase direction for nailing fractures of neck of 405 Fractures of neck of critical analysis of 50 consecutive cases 645
- Fertile period in practice 5 year clinical study 723
- Fetus Obstetric anesthesia 1 Laboratory method for studying effects of anesthetic and anal esthetics on

both uterus and, 179, Note on respiration-like movements of human, 987
 First aid, Modern concept of industrial medical problem, 454
 Fistula, intestinal, Treatment of, of small intestine, 108
 Forearm, Fractures of both bones of, 506
 Fractures, Present status of operative treatment of, 353;
 Malunited, 466, simple, Functional disabilities after, with special reference to importance of bone atrophy in prolongation of disability, 489; treatment, of neck of femur, critical analysis of 50 consecutive cases, 646;
 Treatment of compound, ed 815
 Fracture groups, regional, Organization of, 479
 Fracture service, Place of, in general hospital, 486
 Function, position of, Surgical fusion of wrist joint, 1008

GALL bladder, Conservative treatment of, disease, 79,
 Immediate versus delayed surgery in acute cholecystitis, ed 122; Rate of emptying of human, in pregnancy, 145, Immediate or delayed treatment of acute cholecystitis, liver shock and death, 308, Biliary disease in young subjects, 604, Surgical procedures for biliary calculi, 637, Experimental cholecystitis, 748, Endocholedochal sphincterotomy, 882, Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study, 975, Relation of spasm of second portion of duodenum to biliary colic, 979
 Gastro-intestinal tract, Segmental enteritis, 215
 Genetics, Surgeon as biologist, 257
 Graduate training, for surgery—general surgery and surgical specialties, 1077
 Gynecology, Radical obstetrics and national maternal mortality, 423, Abdominal and pelvic pain—from gynecological viewpoint, 432

HALLUX valgus, 95, 889
 Hands, New McDonald's solution, 246, Fractures of bones of, 500
 Heart, Concerning term "shock," ed 123
 Heels, Spurs of os calcis, 663
 Heredity, Concerning hereditary nature of cancer, ed 247
 Hernia, Inguinal, I Anatomy of region, 186, direct, II. Surgical treatment of, 193
 Hoarseness, 405
 Humerus, Malunited fractures, 466, Fractures of shaft of, 482, Tenosynovitis of long head of biceps humeri, 785, Obstetrical shoulder trauma, 868
 Hurthle cell, tumor of thyroid gland, 1
 Hyperemesis gravidarum, Study of, with special reference to blood chemistry, 858
 Hypoproteinemia, Influence of serum protein on motility of small intestine, 819

ILEUM, Segmental enteritis, 215
 Ileus, Intubation studies of human small intestine
 X Non-surgical method of treating, localizing and diagnosing nature of obstructive lesions, 691
 Incisions, Notes on cutaneous healing in wounds, 140, McBurney, Study of appendicitis, 166
 Industrial medical problem, Modern concept of, 454
 Infections, Anaerobic, following operations on urinary tract, 677
 Instruments and apparatus, Two plane direction finder, for nailing fractures of neck of femur, 495, Metzler, Lewin Stern, Fractures of bones of hand, 500, Carrell device for fracture of forearm, Fractures of both bones of forearm excluding those at elbow joint and wrist joint, 506, Margolin's tube, Surgical treatment of carcinoma of thoracic esophagus with report of 3 successful cases, 534, intestinal tubes, Intubation studies of human small intestine X. Non-surgical

method of treating, localizing and diagnosing nature of obstructive lesions, 691; Drinker and Emerson resuscitators, E and J. resuscitator, Mechanical resuscitation in advanced forms of asphyxia, clinical and experimental study in different methods of resuscitation, 698; Kirwin loop ball disc electrode, Management of bladder tumors, 099, modified Haglund frame, Treatment of low back pain due to functional decompensation, 1032

International Cancer Congress, Third, cor 690
 Intestines, Congenital anomalies of rectum and anus, 11;
 Treatment of fistulas of small, 108, Segmental enteritis, 215, Diverticula of, 314, Aseptic uretero-intestinal anastomosis, 657, Value of determinations of protein prior to operations on gastro-intestinal tract, ed 684;
 Intubation studies of human small, X Non-surgical method of treating, localizing, and diagnosing the nature of obstructive lesions, 691, Carcinoma of rectum, plea for group study and treatment, 760, Choice of sutures in surgery of large ed 814, Influence of serum protein on motility of small, 819, Operability in cancer of rectum, 925

JEFFERSON Medical College, Historical sketch of, 940
 Jejunum, Treatment of peptic ulcer—indications for surgery, 264
 Jenner, Sir William, op 691
 Jonas, August Frederick, 937

KIDNEY, Tuberculosis of, 329, Some physiological and pathological observations on urinary tract during pregnancy, 360, Aseptic uretero-intestinal anastomosis, 657, Anaerobic infections following operations on urinary tract, 677, Transvesical diathermy in treatment of carcinoma of bladder, 027, Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study, 975, Concentration of serum sulphate and blood urea in prostatic hypertrophy associated with urinary obstruction, 994
 Knee, Total tendon transplant for slipping patella, new operation for recurrent dislocation of patella, 199;
 Malunited fractures, 466
 Krukenberg tumors, of ovary, clinical and pathological study of 21 cases, 157

LABOR, complications, Diabetes and pregnancy, 37
 Landmarks in surgery, Surgeon James Mann, U S Army, observations on battlefield amputations, 1072
 Larynx, Hoarseness, 405
 Laxatives, Induced spreading peritonitis complicating acute perforative appendicitis, 947
 Lead poisoning, Recognition and prevention of, 444
 Lengthening, Skeletal distraction of tibia, 012
 Ligamenta flava, Lesions of intervertebral disc and, clinical and anatomical studies, 288
 Light, Effect of, on benzpyrene cancer in mice, 959
 Lips, Epidermoid carcinoma of buccal mucosa, 810;
 Macrocheilia due to hyperplasia of labial salivary glands, operative correction, 1024
 Lister, Antiseptic era, ed 685
 Liver, Thrombophlebitis of appendicular vein complicating acute appendicitis, 62
 Liver shock, Immediate or delayed treatment of acute cholecystitis, and death, 308
 Lumbosacral angle, Treatment of low back pain due to functional decompensation, 1032
 Lungs, Biological surgery in tuberculous patients, 55;
 Mechanical resuscitation in advanced forms of asphyxia, clinical and experimental study in different

- methods of resuscitation 698 Bilateral non tuberculous thopsoas abscess 778 Acute putrid abscess of II Analysis of 45 consecutive operative cases 836 Carcinoma of bronchus clinical and pathological study of 164 cases 902
- Lymph vessels Disturbances of blood and lymph circulation of abdomen 322
- MACROCHEILIA** due to hyperplasia of labial salivary glands operative correction 1024
- Malignancy Surgeon as biologist 257 Correlation of body segmental temperature and its relation to location of carcinomatous metastasis clinical observations and response to methods of refrigeration 512 Symposium on Cancer 512-560
- Mann Surgeon James U S Army observations on battle field amputations 1072
- Martin Edward 1068
- Master Surgeons of America August Frederick Jonas 937
- Mastitis Relation of chronic cystic to carcinoma of breast 300
- Mastoid Surgical treatment of various types of lesions in petrosal pyramid 303
- Maternal mortality Radical obstetrics and national 423
- Maxilla Infections of paranasal sinuses of dental origin 408
- McClellan George Historical sketch of Jefferson Medical College 940
- Medicine Industrial and traumatic surgery 443 Physical therapy in relation to and traumatic surgery 475
- Memoir Edward Martin 1068
- Menstruation Fertile period in practice 5 year clinical study 723 Methods of demonstrating activity of corpus luteum 732
- Metacarpals Fractures of bones of hand 500
- Method Laxalle for tuberculous Biological surgery in tuberculous patients 55 Keller Brandes Hallux valgus 93 Schiller diagnosis of cervical cancer Clinical behavior of early carcinoma of cervix 120 Cleaver for gastric ulcer Technical surgical procedures for gastric and duodenal ulcer 260 Carrel Present status of operative treatment of fractures 353 Gouin theriopuncture Lindner Gust chemical cauterization Weve Modern surgery of retinal detachment 380 skin grafting Reverdin Olier Thiersch Wolfe Krause Gould Complete avulsion of scalp and loss of right ear reconstruction by pedunculated tube grafts and costal cartilage 450 Smith Petersen and Sven Johansson Two plane direction sinder for nailing fractures of neck of femur 405 Torek Surgical treatment of carcinoma of thoracic esophagus with report of 3 successful cases 334 Fothergill Operative injuries of ureter 700 Albee spine fusion operation in treatment of scoliosis 9 Mikulicz Choice of sutures in surgery of large intestine ed 814 Sever capsulotomy Putti rotation osteotomy Obstetrical shoulder trauma 468 Duval and Walzel Endocholecholeal sphincterotomy 882 Silver capsular flap Hallux valgus 880 Kewin clamp Management of bladder tumors 990 Drouin hysterectomy Correction of cystocele and rectocele in process of supravaginal hysterectomy 1038
- Morphine Relation of spasm of second portion of duodenum to biliary colic 99
- Mouse sarcoma Effect of subcutaneous injections of concentrated spleen extract on mouse sarcoma 180 563
- Mouth Epidermoid carcinoma of buccal mucosa 810
- Muscle internal oblique transversus abdominis Inguinal hernia I Anatomy of region 186 extra-ocular Some principles involved in surgery of 385 psoas Bilateral non tuberculous thopsoas abscess 78
- Muscle spasm Intravenous calcium chloride and for relief of visceral colic clinical and experimental study 975
- Musculus biceps humeri, Tenosynovitis of long biceps 785
- NASOPHARYNX** Malignant neoplasms of 400 Nerve laryngeal Routine dissection and demonstration recurrent in subtotal thyroidectomy 775 Nerve centers exhaustion of Surgeon as biologist Neural folds Filonidal cysts 431 Nipple Paget's disease of 523 Norway Some Scandinavian clinics, ed 933 Nose Malignant neoplasms of nasopharynx 400
- OBSTETRICS** Diabetes and pregnancy 37 Ob anesthesia I Laboratory method for studying of anesthetic and analgesic agents on both uterine fetus 570 Radical and national maternal mortality 423 Water balance in relation to toxemias of pregnancy 426 Cesarean section 437 Studies on nutrition in pregnancy II Vital capacity observation in normal pregnant women 591 Fertile pen practice 5 year clinical study 723 Study of h emesis gravidarum with special reference to chemistry 838 Obstetrical shoulder trauma Note on respiration like movements of human 987 Retraction ring dystocia its cause and treatment 1047
- Oils Vitamin in treatment of burns experimental 622
- Osteocalcium Spurs of 663
- Os purum Use of in bone implantations, with reference to its use in tuberculous bone and lesions 23
- Ovary Krukenberg tumors of clinical and pathological study of 21 cases 157
- Ovulation Fertile period in practice 5 year clinical study 723
- PAGET** Sir James op 129 Paget's disease of nipple 525
- Pain Lesions of intervertebral disc and ligaments clinical and anatomical studies 298 Abdominal pelvic from gynecological viewpoint 432 low b Physical therapy in relation to industrial medical and traumatic surgery 475 spasmodic Intravenous calcium chloride and its use for relief of visceral colic and experimental study 975 spasmodic lation of spasm of second portion of duodenum biliary colic 979 low back Treatment of duodenal functional decompensation 1032
- Pancreas Acute pancreatitis 348
- Papilla of Vater Intracutaneous dilatation of experiment and clinical observations 100
- Paralysis obstetrical Volkmann's spastic Surgical fixation of wrist joint 1008
- Pasteur Antiseptic era ed 683
- Patella Total tendon transplant for slipping new operation for recurrent dislocation of 199
- Pathology Some physiological and pathological observations on urinary tract during pregnancy 360
- Pelvis Floor of Upper pelvic floor and its importance total abdominal hysterectomy 44 Abdominal pelvic pain—from gynecological viewpoint 432
- Peptic ulcer Treatment of indications for surgery Technical surgical procedures for gastric and duodenal ulcer 260 Extent and character of and gastritis in different countries 666

ntoneum, Induced spreading peritonitis complicating acute perforative appendicitis, 947
 strosal pyramid, Surgical treatment of various types of lesions in, 395
 halanges, Fractures of bones of hand, 500
 harynx, Malignant neoplasms of nasopharynx, 400
 hysical therapy, in relation to industrial medicine and traumatic surgery, 475
 hysician and surgeon, collaboration of, Treatment of peptic ulcer—indications for surgery, 264
 hysiology, Some physiological and pathological observations on urinary tract during pregnancy, 360
 blondal cyst, 231
 leura, Bilateral non-tuberculous iliopectus abscess, 778;
 Acute putrid abscess of lung II Analysis of 45 consecutive operative cases, 836
 neumonia, complication, Bilateral non-tuberculous iliopectus abscess, 778
 oison, lead, Recognition and prevention of, 444
 ott's fracture, Malunited fractures, 466
 regnancy, Diabetes and, 37, Rate of emptying of human gall bladder in, 145, Some physiological and pathological observations on urinary tract during, 360;
 Water balance in relation to toxemias of, 426, Cesarean section, 437, Syphilis in pregnant women, 441, Studies on circulation in, II. Vital capacity observations in normal pregnant women, 591, Advanced extra-uterine pregnancy, 671, Fertile period in practice, 5 year clinical study, 723, Methods of demonstrating activity of corpus luteum, 732, toxemias of, Study of hyperemesis gravidarum with special reference to blood chemistry, 858; Note on respiration-like movements of human fetus, 987
 reservatves, for blood, Inexhaustible source of blood for transfusion and its preservation, preliminary report, 176
 prostate, Anaerobic infections following operations on urinary tract, 677, Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study, 975, Concentration of serum sulphate and blood urea in prostatic hypertrophy associated with urinary obstruction 994
 Proteins, Value of determinations of, prior to operations on gastro-intestinal tract, ed 684

RADIUS, Fractures of both bones of forearm excluding those at elbow joint and wrist joint, 506
 Reaction, Wassermann, Syphilis in pregnant woman, 441
 Rectum, Congenital anomalies of, and anus, 11, Conduction analgesia in anorectal surgery, 105; Impalement of, 222, Treatment of cancer of, 527, Visceral metastasis from rectal carcinoma, 611, Carcinoma of, plea for group study and treatment, 769, Operability in cancer of 925, Correction of cystocele and rectocele in process of supravaginal hysterectomy, 1038; Ambulatory operative treatment of anorectal pathology, 194 consecutive operations performed under local anesthesia of prolonged duration, 1054
 Refrigeration, Correlation of body segmental temperature and its relation to location of carcinomatous metastasis clinical observations and response to methods of, 512
 Respiration-like movements of human fetus, Note regarding 987
 Resuscitation, Mechanical, in advanced forms of asphyxia, clinical and experimental study in different methods of 608
 Retina Modern surgery of retinal detachment, 380
 Retraction ring, dystocia; its cause and correction, 1047
 Ribs Injuries of chest and abdomen, 448

SACRO-ILIAC joint, Lesions of intervertebral disc and ligamenta flava, clinical and anatomical studies, 288;
 Treatment of low back pain due to functional decompensation, 1032
 Salivary glands Macrocheilia due to hyperplasia of labial, operative correction, 1024
 Sarcoma 180, Effect of subcutaneous injections of concentrated spleen extract on mouse 563
 Scalp, Complete avulsion of and loss of right ear reconstruction by pedunculated tube grafts and costal cartilage, 459, Value of delayed single pedicle skin flaps in plastic repair of 890
 Scandinavian clinics Some, ed 933
 Scoliosis, Albee spine fusion operation in treatment of, 797
 Serum protein, Influence of, on motility of small intestine, 819
 Serum sulphate, Concentration of, and blood urea in prostatic hypertrophy associated with urinary obstruction, 994
 Sesamoids, Hallux valgus, 889
 Shock, Concerning term, ed 123, Surgeon as a biologist, 257, Modern treatment of burns, ed 1064, ed 1065
 Shoulder, Tenosynovitis of long head of biceps humeri, 785; Obstetrical, trauma, 868
 Sinus, paranasal, Infections of, of dental origin 408
 Skeletal distraction, of tibia 912
 Skin, Notes on cutaneous healing in wounds, 140, Effect of light on benzpyrene cancer in mice, 980
 Skin flaps, delayed pedicle, Value of single, in plastic repair of scalp, 899
 Solution, McDonald's, New, 246
 Sphincter, of Oddi, Endocholedochal sphincterotomy, 882
 Spine, Lesions of intervertebral disc and ligamenta flava, clinical and anatomical studies, 288, Albee, fusion operation in treatment of scoliosis, 797
 Spleen extract, Effect of subcutaneous injections of concentrated, on mouse sarcoma, 180, 563
 Splints, Fractures of both bones of forearm excluding those at elbow joint and wrist joint, 506
 Spurs, of os calcis, 663
 State medicine, Some Scandinavian clinics, ed 933
 Sterility, Fertile period in practice, 5 year clinical study, 723
 Sterilization, Bacterial species found in non-sterile surgical catgut sutures, 878
 Stomach, Treatment of peptic ulcer—indications for surgery, 264, Technical surgical procedures for gastric and duodenal ulcer, 269, Extent and character of peptic ulcers and gastroduodenitis in different countries, 666; Value of determinations of protein prior to operations on gastro-intestinal tract, ed 684; Influence of serum protein on motility of small intestine, 819
 Strabismus, Some principles involved in surgery of extraocular muscles, 385
 Streptococcus, micro-aerophilic hemolytic, Uterus bicornis duplex associated with infection due to, 117
 Surgeon, as biologist, 257, and physician, collaboration of, Treatment of peptic ulcer, indications for surgery, 264
 Surgery, Biological, in tuberculous patients, 55, complications, Treatment of fistulas of small intestine, 108, Immediate or delayed, in acute cholecystitis ed 122; technique, Notes on cutaneous healing in wounds, 140, emergency, Impalement of rectum, 222, American College of Surgeons and cultural aspects of, 414; traumatic, Industrial medicine and, 443, traumatic, Physical therapy in relation to industrial medicine and, 475, complications, Relation of catgut sensitivity to wound healing, 628, pre-operative and postoperative care, Antiseptic era, ed 685, complications, Operative injuries of ureter 790, technique Choice of sutures in, of large intestine, ed 814, technique, Bac-

terial species found in non sterile surgical catgut sutures 878

Sutures Choice of in surgery of large intestine ed 814

Sweden Some Scandinavian clinics ed 933

Syphilis in pregnant woman 441 Epidermoid carcinoma of buccal mucosa 810

TEACHING graduate American College of Surgeons and cultural aspects of surgery 414

Teeth Infections of paranasal sinuses of dental origin 408

Temperature body segmental Correlation of and its relation to location of carcinomatous metastasis clinical observations and response to methods of refrigeration 372

Temporal bone Surgical treatment of various types of lesions in petrosal pyramid 393

Tendon transplantation Total for slipping patella new operation for recurrent dislocation of patella 199 long head biceps humeri Tenosynovitis of 783

Theory Bichat Biological surgery in tuberculous patients 55

Thorax Acute putrid abscess of lung II Analysis of 45 consecutive operative cases 836

Thyroid gland Hurthle cell tumor of 1 Carcinoma of thyroid 536 Malignant adenoma of local recurrences in veins of neck 577 Routine dissection and demonstration recurrent laryngeal nerve in subtotal thyroidectomy 775

Tibia Skeletal distraction of 912

Toe great Hallux valgus 92

Trachoma situation in China 389

Tuberculosis Use of *os purum* in bone implantations its use in tuberculous bone and joint lesions 23 Biological surgery in tuberculous patients 55 of kidney 329 Surgical fusion of wrist joint 1008

ULNA Fractures of both bones of forearm excluding those at elbow joint and wrist joint 506 epiphysis of Surgical fusion of wrist joint 1008

Ureter Tuberculosis of kidney 329 Some physiological and pathological observations on urinary tract during pregnancy 360 Cystectomy and transplantation of into bowel for carcinoma of bladder 549 Aseptic uretero intestinal anastomosis 657 Anaerobic infections following operations on urinary tract 67 Operative injuries of 790 Intravenous calcium chloride and its use for relief of visceral colic clinical and experimental study 975

Urethra Congenital anomalies of rectum and anus.

Operative injuries of ureter 790 Intravenous calcium chloride and its use for relief of visceral colic and experimental study 975

Urinary tract Some physiological and pathological observations on urinary tract during pregnancy Anaerobic infections following operations on urinary tract 677

Uterus Upper pelvic floor and its importance in total abdominal hysterectomy 44 Interposition operation with sterilization 88 bicornis duplex associated with infection due to micro aerophilic hemolytic streptococcus 117 cervix Clinical behavior of early carcinoma of cervix 129 Krukenberg tumors of ovary clinical and pathological study of 21 cases 157 Uterine anesthesia I Laboratory method for studying effects of anesthetic and analgesic agents on both and fetus 179, Advanced extra uterine pregnancy 671 cervix Non invasive potential carcinoma of cervix 822 Retraction ring dystocia its cause and correction 1047

VAGINA Congenital anomalies of rectum and anus 15 Upper pelvic floor and its importance in total abdominal hysterectomy 44 Correction of cystocele and rectocele in process of supravaginal hysterectomy 1038

Vanadium steel plates Present status of operative treatment of fractures 353

Varicose veins Thrombophlebitis of 236

Vein appendicular, Thrombophlebitis of complicating acute appendicitis 62

Vertebrae Albee spine fusion operation in treatment of scoliosis 797

Vertebral canal, Pilonidal cysts 231

Visceral metastasis from rectal carcinoma 612

Vital capacity Studies on circulation in pregnancy II Vital capacity observations in normal pregnant women 591

Vitamin oils in treatment of burns experimental study 612

WAR of 1812 medical history Surgeon James Mann, US Army observations on battlefield amputations 1072

Water balance in relation to toxemias of pregnancy 416

Wound healing Notes on cutaneous healing in wounds 140 Relation of catgut sensitivity to 618

Wrist joint Surgical fusion of 1008

BOOK REVIEWS

- ALEXANDER, JOHN The Collapse Therapy of Pulmonary Tuberculosis, 943
- ANKLESARIA, S. B The Rabbit Test, for the Detection of Chorionic Tissue in the Body and the Determination of its Proliferative Activity With a foreword by Dr Lmil Novak, 255
- BAILEY, HAMILTON. Demonstrations of Physical Signs in Clinical Surgery, 6th rev ed, 1075
- BARRINGTON-WARD, LANCELOT The Abdominal Surgery of Children, 2d ed, 687
- BERTWISTLE, A P The Role of Chemiotaxis in Bone Growth, 1075
- BULLOW, JESSE G M The Management of the Pneumonias, for Physicians and Medical Students, 687
- COUFVILLE, CYRIL B Pathology of the Central Nervous System, a Study Based upon a Survey of Lesions Found in a Series of Fifteen Thousand Autopsies, 255
- DAVIS, GEORGE G, SALMONSEN, ELLA M, and EARLYWINE, JOSEPH L The Pneumonokonioses (Silicosis) Literature and Laws Book III, 253
- DAVIS LOYAL J B Murphy; Stormy Petrel of Surgery, 943
- FRANKLIN, KENNETH J A Monograph on Veins, 689
- FRIEDMAN, LEWIS J Textbook of Diagnostic Roentgenology, 253
- GASK, GEORGE E, and ROSS, J PATERSON The Surgery of the Sympathetic Nervous System, 2d ed., 1074
- GLOBUS, J. H Practical Neuroanatomy, a Textbook and Guide for the Study of the Form and Structure of the Nervous System, 689
- HANKE, HANS Innere Sekretion und Chirurgie, 1075
- HOLLENDER, ABRAHAM R Physical Therapeutic Methods in Otolaryngology, 253
- HOLMAN, EMILE Arteriovenous Aneurysm, Abnormal Communications between the Arterial and Venous Circulations, 688
- JORDAN, HARVEY ERNEST A Textbook of Histology, 7th ed, 254
- KAPLAN, IRA I. Radiation Therapy; its Use in the Treatment of Benign and Malignant Conditions, 688
- KNYVETON, JOHN The Diary of a Surgeon in the Year 1751-1752 Edited and transcribed by Ernest Gray, 687
- KRACKE, ROY R, and GARVER, HORTENSE ELTON Diseases of the Blood and Atlas of Hematology, with Clinical and Hematologic Descriptions of the Blood Diseases Including a Section on Technic and Terminology, 944
- KURZROK, RAPHAEL The Endocrines in Obstetrics and Gynecology, 128
- MACKEE, GEORGE M, and CIPOLLARO, ANTHONY C Cutaneous Cancer and Precancer, 1074
- MAINGOT, RODNEY. Post-Graduate Surgery Edited by Rodney Maingot. Vol 3, 816
- MUIR and RITCHIE's Manual of Bacteriology Revised by Carl H Browning and Thomas J Mackie 10th ed., 1075
- ORMSBY, OLIVER S A Practical Treatise on Diseases of the Skin. With revision of the Histopathology and Mycology by Clark Wylie Finnerud 5th rev ed, 817
- OSGOOD, EDWIN E, and ASHWORTH, CLARICE M Atlas of Hematology, 254
- The Practitioners Library of Medicine and Surgery Vol 12—Preventive Medicine and Hygiene, 255
- PRICE, FREDERICK W. A Textbook of the Practice of Medicine By Various Authors Edited by Frederick W. Price 5th ed, 687
- SIMONS, EDWIN J Primary Carcinoma of the Lung, 1074
- SMITH, HOMER W The Physiology of the Kidney, 817
- TODD, MABEL ELSWORTH The Thinking Body, a Study of the Balancing Forces of Dynamic Man Foreword by E G Brackett, 687
- WANGENSTEEN, OWEN H The Therapeutic Problem in Bowel Obstructions, a Physiological and Clinical Consideration, 816
- WEISS, EDWARD Practical Talks on Kidney Disease, 128

- terial species found in non sterile surgical catgut sutures 876
 Sutures Choice of in surgery of large intestine, ed 814
 Sweden Some Scandinavian clinics ed 933
 Syphilis in pregnant woman 431 Epidermoid carcinoma of buccal mucosa 810

- T**EACHING graduate American College of Surgeons and cultural aspects of surgery 414
 Teeth Infections of paranasal sinuses of dental origin 408
 Temperature body segmental Correlation of and its relation to location of carcinomatous metastasis clinical observations and response to methods of refrigeration 512
 Temporal bone Surgical treatment of various types of lesions in petrosal pyramid 305
 Tendon transplantation Total for slipping patella new operation for recurrent dislocation of patella 199
 long head biceps humeri Tenosynovitis of 785
 Theory, Buchat Biological surgery in tuberculous patients 55
 Thorax Acute putrid abscess of lung II Analysis of 43 consecutive operative cases 836
 Thyroid gland Hurthle cell tumor of 1 Carcinoma of thyroid, 536 Malignant adenoma of local recurrences in veins of neck 577 Routine dissection and demonstration recurrent laryngeal nerve in subtotal thyroidectomy 775
 Tibia Skeletal distraction of 912
 Toe ganglion Halux valgus 95
 Trachoma situation in China 389
 Tuberculosis Use of os purum in bone implantations its use in tuberculous bone and joint lesions 3 Biological surgery in tuberculous patients 55 of kidney 329
 Surgical fusion of wrist joint 1008

- U**RNA Fractures of both bone of forearm excluding those at elbow joint and wrist joint 506 epiphysis of Surgical fusion of wrist joint, 1008
 Ureter Tuberculosis of kidney 329 Some physiological and pathological observations on urinary tract during pregnancy 360 Cystectomy and transplantation of into bowel for carcinoma of bladder 549 Repture uretero intestinal anastomosis 657 Anaerobic infections following operations on urinary tract 67 Operative injuries of 790 Intravenous calcium chloride and its use for relief of visceral colic clinical and experimental study 975

- Urethra, Congenital anomalies of rectum and a 11
 Operative injuries of ureter 790 Intravenous calcium chloride and its use for relief of visceral colic, clinical and experimental study 975
 Urinary tract Some physiological and pathological observations on urinary tract during pregnancy 360 Anaerobic infections following operations on urinary tract 677
 Uterus Upper pelvic floor and its importance in total abdominal hysterectomy 44 Interposition operation with sterilization 88 bicornis duplex associated with infection due to micro aerophilic hemolytic streptococcus 117 cervix Clinical behavior of early carcinoma of cervix 129 Krukenberg tumors of ovary clinical and pathological study of 21 cases 157 Obstetric anesthesia I Laboratory method for studying effects of anesthetic and analgesic agents on both and fetus 170, Advanced extra uterine pregnancy 671 cervix Non invasive potential carcinoma of cervix 822 Retraction ring dystocia its cause and correction 1047

- V**AGINA Congenital anomalies of rectum and anus, 11 Upper pelvic floor and its importance in total abdominal hysterectomy 44 Correction of cystocele and rectocele in process of supravaginal hysterectomy 1038
 Vanadium steel plates Present status of operative treatment of fractures 353
 Varicose veins Thrombophlebitis of 246
 Vein appendicular Thrombophlebitis of complicating acute appendicitis 62
 Vertebra Albee spine fusion operation in treatment of scoliosis 797
 Vertebral canal Philoid cysts 231
 Visceral metastasis from rectal carcinoma 612
 Vital capacity Studies on circulation in pregnancy II Vital capacity observations in normal pregnant women 591
 Vitamin oils in treatment of burns experimental study 622
WAR of 1812 medical history Surgeon James Mann U.S. Army observations on battlefield amputations 1072
 Water balance in relation to toxemias of pregnancy 426
 Wound healing Notes on cutaneous healing in wounds 140 Relation of catgut sensitivity to 623
 Wrist joint Surgical fusion of 1008

